UNITED STATES TARIFF COMMISSION
WASHINGTON

Tariff Information Series—No. 18

Barytes, Barium Chemical, and Lithopone Industries

Including

Costs of Production, 1919

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INTRODUCTION.

This pamphlet is a survey of existing conditions in the barytes, barium chemical, and lithopone industries, with special reference to the rôle of the tariff in their development in the United States. It includes a study of the costs of production in the three related industries.

The report as presented is divided into five parts, as follows:

I. *Summary of the barytes, barium chemical, and lithopone industries.*—This cites the provisions in the tariff act of 1913 covering the articles discussed in the report and presents the salient competitive conditions relating to the three allied industries.

II. *The barytes industry.*—This chapter discusses the trade statistics of the barytes industry, the principal producing countries, recent developments in the domestic industry, and the relation of the barytes industry to the barium chemical and lithopone industries.

III. *The barium chemical industry.*—Our prewar dependence on imports of this class of chemical salts and the establishment of an industry in this country during the war are discussed in detail.

IV. *The lithopone industry.*—The dependence of this industry on imported barytes prior to the war, the effect of the lithopone industry on the development of domestic deposits of barytes, and the requirements of the lithopone industry are pointed out.

V. *Costs of production in the barytes, barium chemical, and lithopone industries.*—This chapter gives in considerable detail the cost of producing crude barytes in western and southern mines in 1916 and 1919; the cost of producing ground barytes in 1914, 1916, and 1919, and of barium chemicals and lithopone in 1919.

In the preparation of this report the Tariff Commission had the services of C. R. DeLong, G. P. Comer, and E. M. Whitcomb, of the Commission's staff.

PART I

SUMMARY OF THE BARYTES, BARIUM CHEMICAL AND LITHOPONE INDUSTRIES

PART I.

SUMMARY OF THE BARYTES, BARIUM CHEMICAL, AND LITHOPONE INDUSTRIES.

The articles discussed in this report are provided for as follows in the tariff act of October 3, 1913:

10. Barium, chloride of, ¼ cent per pound; dioxide of, 1½ cents per pound; carbonate of, precipitated, 15 per centum ad valorem.

51. Baryta, sulphate of, or barytes, including barytes earth, unmanufactured, 15 per centum ad valorem; manufactured, 20 per centum ad valorem; blanc-fixe, or artificial sulphate of barytes, * * * 20 per centum ad valorem.

61. * * * lithopone and white sulphide of zinc, 15 per centum ad valorem.

BARYTES.

The source of barium is the naturally occurring minerals—barytes (barium sulphate) and witherite (barium carbonate). Metallic barium is, at present, of no industrial importance. The barium compounds manufactured from these minerals, by chemical processes, constitute an important class of commercial articles. Barytes, the more widely distributed ore, is the one generally used. England and Germany possess, in addition to barytes, deposits of witherite, which can be mined economically, and a small portion of the demand is supplied by this mineral. Barytes, on account of its whiteness, high specific gravity, and chemical inertness, is used in the ground form chiefly as a filler in paints, paper, linoleum, and rubber goods. Its use as a raw material in the manufacture of the pigment, lithopone, and the various barium chemicals is important. In 1917, with a maximum consumption of barytes, about 43 per cent was used in the manufacture of lithopone, 25 per cent in barium chemicals, and the remainder in ground barytes. Witherite is used chiefly as a filler in rubber goods and in the manufacture of barium chemicals.

Prior to the war the domestic barytes industry supplied from 55 to 65 per cent of the consumption (80,000 tons in 1913) of crude barytes in the United States. Lithopone was then the only product manufactured in this country on a large scale from crude barytes by chemical processes, and the barytes necessary for its production was imported, chiefly from Germany. Before the war Germany was the largest producer of barytes, with an output of about 300,000

short tons a year. Great Britain ranked second and the United States third. The domestic production of crude barytes, under war conditions, increased fourfold, from about 50,000 tons in 1914 to over 200,000 tons in both 1916 and 1917. The production of the United States is now second only to Germany's prewar output. The production of crude barytes in this country during the war was sufficient to meet domestic requirements.

The domestic industry prior to the war was localized; about 65 per cent of the output of crude barytes was mined in Missouri and supplied mid-western manufacturers of ground barytes. During the war the increased domestic demand was met largely by the development of southern deposits of barytes in Georgia, Tennessee, and Kentucky, and by a doubling of production in Missouri. The greatest (State) production shifted from Missouri to Georgia in 1916. Since 1915 Georgia has supplied about 50 per cent of the total domestic output. The industry as it now exists is in two distinct localities—(1) the middle western district, represented chiefly by Missouri, and (2) the southern district, represented chiefly by Georgia, Tennessee, and Kentucky. In addition to these two producing localities, there are two principal markets for crude barytes—the Atlantic coast market (from Baltimore to New York) and the middle western market (St. Louis and Chicago). The western producers and consumers are little affected by a tariff on *crude* barytes. On the other hand, eastern consumers of barytes before the war secured their supplies chiefly from Germany. Since the cessation of imports the Atlantic coast market has been supplied with crude barytes from the southern producing district, because of the differential in freight rates of $1.24 a short ton (May 29, 1920) in favor of this district over the middle western district. This localization of the industry complicates the tariff problems.

Prior to the war domestic ground barytes produced in the middle western district was able to compete in the Atlantic coast market with imported ground barytes under the duty of $5.25 per ton (act of 1909). At that time foreign competition was chiefly in the crude grade, imports of ground barytes being only about 15 per cent of the imports of the crude. During the war middle western ground barytes continued to supply a large part of the Atlantic coast market, notwithstanding the advantage of the southern district in freight rates. This may be accounted for by the fact that the middle western ore is a softer variety and grinds easier, and by the circumstance that the southern deposits were developed primarily to supply the raw material requirements of the eastern lithopone and barium chemical manufacturers. The producers in the southern district are therefore particularly interested in maintaining the eastern market for crude barytes, while the middle western producers are more in-

terested in retaining this same market for ground barytes. The situation in regard to an outlet for middle western crude barytes has been improved during the war by the establishment in the Middle West of lithopone plants, which require crude barytes as their raw material.

The extent and availability of deposits in the United States are important factors in connection with the tariff. Unfortunately, little definite, official information is available, and owing to the general nature of deposits it would be practically impossible to arrive at an accurate estimate of the total domestic resources. Under the stimulus of war conditions the domestic production supplied the entire domestic consumption. The possibility of increasing the present output of barytes appears to be most promising in the Georgia and Tennessee districts. These districts seem to contain large quantities of ore and could probably be developed to meet an increased demand of eastern manufacturers. In these districts, however, geological and geographical disadvantages will probably hinder domestic barytes from competing on even terms in the Atlantic coast market with crude barytes imported from Germany.

BARIUM CHEMICALS.

The barium chemicals discussed in this report include the barium salts mentioned in paragraph 10, and blanc fixe in paragraph 51, of the act of 1913, as well as other barium salts not mentioned specifically in the tariff. These chemicals, which are made either from barytes or witherite, have important industrial uses. The most important are as follows: *blanc fixe*, or precipitated barium sulphate (which is practically identical with ground barytes in chemical composition, but different in physical properties), used as an inert filler or pigment where a pure white product is necessary; *barium carbonate*, used chiefly in ceramics in the manufacture of enamel ware and some kinds of optical glass; *barium chloride*, used principally in the manufacture of blanc fixe and color lakes; and *barium dioxide*, used as the raw material for the production of hydrogen peroxide.

Prior to the war the United States was wholly dependent on imports for its supply of barium chemicals. Germany was the largest producer and furnished about two-thirds of the domestic requirements. About 90 per cent of the imports in 1914 were represented by three barium salts—barium carbonate, barium chloride, and barium dioxide. The cessation of imports and the war demand for barium chemicals (barium nitrate, blanc fixe, and barium dioxide) resulted in the establishment of an industry in this country. Domestic plants have been located chiefly in the East and Southeast, although there

are also plants in Ohio and Illinois. In some cases the plants have been located in close proximity to the domestic deposits of barytes. The output of barium chemicals has increased steadily each year from about 17,000,000 pounds in 1915 to over 46,000,000 pounds in 1918. The principal salts produced are blanc fixe, barium carbonate, and barium chloride, in the order of production in 1918. The domestic production of 46,000,000 pounds in 1918 may be compared with an importation in 1914 of 19,000,000 pounds in order to show the increased consumption of barium chemicals in the United States.

The chief markets for barium chemicals are in the East, and with normal conditions restored, the industry will be subjected to competition in these markets from imported barium chemicals. Eastern plants are so situated that they can use either imported or domestic barytes as the raw material. Those plants located close to the southern barytes deposits and in the Middle West will depend largely on domestic barytes. It is evident that a duty on barium chemicals should be considered in conjunction with a duty on the raw material, barytes.

LITHOPONE.

Lithopone, a white pigment, is a mixture consisting of about 70 per cent of barium sulphate and about 30 per cent of zinc sulphide. When first introduced, lithopone was known as "white sulphide of zinc," but this term, although retained in the tariff of 1913, is no longer in general use. Lithopone is used extensively in flat and enamel wall paints and as an inert filler in rubber goods, paper, linoleum, oilcloth, and window-shade cloth.

The raw materials for the manufacture of lithopone include barytes, coal or coke, zinc, and sulphuric acid. Prior to the war the entire lithopone industry was located along the Atlantic coast at or within a short distance of tidewater. The barytes requirements of the industry were supplied by imports, chiefly from Germany, at a cost less than the price at which domestic barytes could be purchased. War conditions forced lithopone manufacturers to develop southern deposits of barytes in order to have a supply of raw material. At the same time the manufacture of lithopone was started in the Middle West, thereby utilizing locally available crude barytes. An adequate supply of barytes is essential to the lithopone industry and should be given attention in considering duties on crude barytes and lithopone.

From 1910 to 1919 the domestic production of lithopone increased nearly sixfold, or from 25,000,000 pounds to about 145,000,000 pounds. The output during this period supplied from 84 to 100 per cent of the domestic consumption. On a basis of the 1919 production, about 80 per cent of the lithopone is produced in the Atlantic

coast district. The imports of lithopone have been small; the maximum importation was 7,500,000 pounds in 1914, compared with a domestic production the same year of about 65,600,000 pounds. Although there has been no official report of exports, it is known that a considerable export trade in lithopone has been developed during 1920.

Since barytes is one of their raw materials, lithopone manufacturers are naturally interested in obtaining a supply at the lowest possible cost, and they generally favor a low duty on crude barytes. Barytes enters into the cost of lithopone to the extent of about 14 per cent of the total factory cost, as shown under the cost of production on page 87. The effect of an increase or decrease in the cost of barytes, due to tariff influences or other causes, on the total cost of lithopone can, therefore, be calculated. Theoretically, any duty on lithopone should be compensatory of the duty on crude barytes to the extent revealed by the percentage of total cost given above. There are other factors entering into a consideration of the bearing of the tariff on lithopone, such as the competition between lithopone and other paint pigments.

PART II

THE BARYTES INDUSTRY

PART II.

THE BARYTES INDUSTRY.

DESCRIPTION AND USES.

Barium occurs in nature as the minerals—barytes (barium sulphate) and witherite (barium carbonate). The chemical compounds manufactured from these raw materials constitute an important class of commercial articles. Barytes is the more widely distributed ore and is the one generally used in the United States. The United Kingdom and Germany also possess witherite deposits which are used in the manufacture of barium chemicals. Barytes, also known as "barite," "heavy spar," and "tiff," is composed chiefly of barium sulphate ($BaSO_4$). When pure it consists of 65.7 per cent of barium oxide (BaO) and 34.3 per cent of sulphur trioxide (SO_3). It is usually a white, opaque or translucent mineral, but it is also found stained pink or brown owing to the presence of oxides of iron. The commercial grades of crude barytes contain from 90 to 95 per cent of barium sulphate. Crude barytes is graded according to the amount and kinds of impurities which it contains; particular attention is paid to the content of iron, lead, zinc, and silica. In trade two types of crude barytes are recognized, the "hard crystalline" variety and the "soft" variety. The former has a glassy appearance and can not be broken in the hand, while the soft variety has a milky appearance and can be easily crumbled. The soft type is preferred by the grinders, as it gives the highest grade of ground barytes because of its texture and because the impurities are such that they can be dissolved and eliminated by an acid bath. This grade is not so hard on the grinding machinery and is said to roast better than the hard variety. The hard variety can be used to better advantage in the lithopone and barium chemical industries than in the manufacture of ground barytes. Both the hard and soft barytes are found in this country. That found in Missouri is a soft friable ore. The barytes found in the Cartersville (Ga.) district is a hard crystalline ore. Both types are found in the Sweetwater (Tenn.) fields, the soft ore approaching the Missouri ore and the hard ore closely resembling the Cartersville ore.

The commercial uses of barytes, as such, are largely dependent on the fact that it is a heavy, white mineral, chemically inert, and comparatively cheap. The market price of crude barytes depends to a

large extent on the ease with which it can be ground, and that of ground barytes depends on color, fineness of grinding, and to some extent on its chemical purity.

Barytes as it enters commerce may be distinguished as follows:

1. Crude barytes, barytes ore, or "tiff," as it is known locally in Missouri, is the natural mineral in the condition in which it is mined, or after it has been washed and jigged to remove earthy and mineral impurities. This grade of barytes is used as the raw material for the manufacture of ground barytes, barium chemicals, and lithopone.

2. Ground barytes is the crude ore which has been washed, jigged, and ground very fine. If the natural mineral is of the desired degree of whiteness, which is rarely the case in this country, it receives no further treatment than grinding. Ground barytes which is not pure white may be sold as ground barytes "off color" or "unbleached." This grade is used for dark-colored paints and as a filler by the paper industry, chiefly in the manufacture of heavy, stiff materials such as playing cards and Bristol boards. Ground barytes which is not pure white in color may be bleached by means of sulphuric acid which dissolves and removes the iron. This grade of ground barytes is known as "prime white" or "floated" barytes. It is used as a pigment in white paints and as a filler in paper, rubber goods, "artificial ivory," and for other purposes where a white, inert pigment or filler is desired.

Blanc fixe is precipitated barium sulphate produced by treating a solution of a barium salt with sodium sulphate (salt cake). This product, while having the same chemical composition, is different in physical properties from ground barytes. It is essentially a manufactured product and is therefore discussed under the barium chemical industry. (See p. 41.)

Barytes is the only domestic source of barium products. There is, however, a small quantity of witherite imported, which is used in the manufacture of barium chemicals. Witherite is a naturally occurring mineral composed chiefly of barium carbonate ($BaCO_3$). When pure it contains 77.6 per cent of barium oxide. Witherite has about the same hardness and specific gravity as barytes. It is easily decomposed by acids, which fact gives it advantages over barytes in the manufacture of certain barium chemicals. It is also used as an inert filler in the rubber industry. In England it is reported to be used chiefly for manufacturing barium chemicals, and it is also used in Germany for this purpose.

Table 1 shows the distribution of crude barytes according to the three principal consuming industries—ground barytes, lithopone, and barium chemicals. The total in this table does not necessarily correspond with the total production as some minor uses are not included and discrepancies may also be accounted for by

stocks in manufacturers' hands. The decrease in the consumption of crude barytes in 1918 is accounted for chiefly by a decrease in the quantity of crude barytes consumed in the manufacture of barium chemicals.

TABLE 1.—*Crude barytes used in the manufacture of barium products.*

[From Mineral Resources, U. S. Geological Survey.]

Calendar year.	For barium chemicals.	For ground barytes.	For lithopone.	Total.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*
1915	10,216	53,903	44,503	108,622
1916	38,283	75,507	71,898	185,688
1917	49,842	60,132	86,065	196,039
1918	38,041	60,460	85,282	183,783
1919 [1]	27,696	63,051	103,968	194,715

[1] Preliminary figures furnished by courtesy of the U. S. Geological Survey, subject to revision.

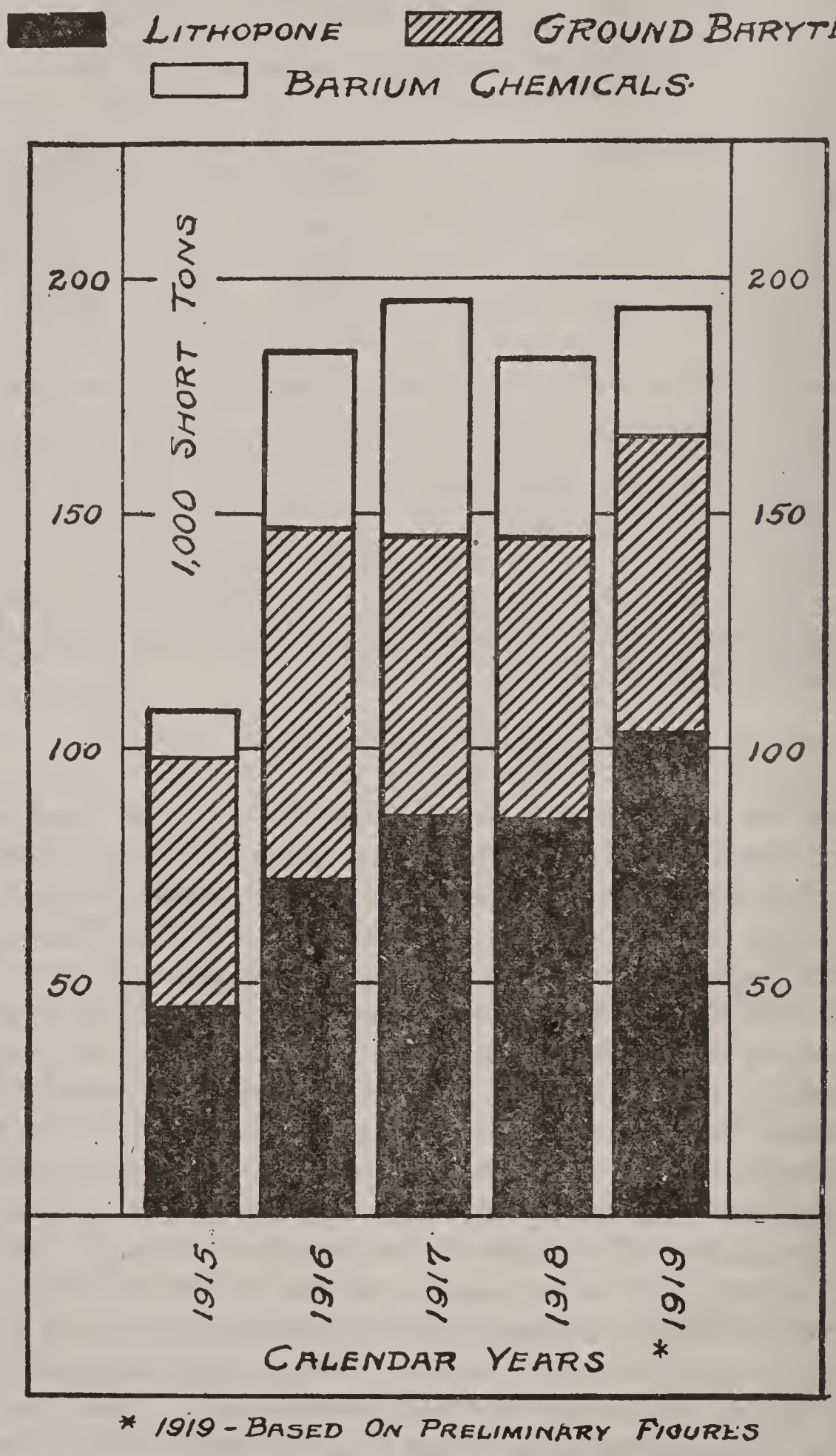
As can be seen from Table 1, the manufacture of lithopone and barium chemicals is an important outlet for crude barytes. In 1917, with a maximum consumption of crude barytes, the lithopone industry required about 43 per cent and the barium chemical industry about 25 per cent of the total quantity of crude barytes consumed in the United States. Figure 1 shows graphically the consumption of crude barytes by industries.

DOMESTIC PRODUCTION.

Production and consumption.—From 35 to 45 per cent of the domestic consumption of crude barytes prior to 1914 was imported chiefly from Germany. The imported product supplied the Atlantic coast market as it could be obtained at a cost less than that of domestic crude barytes. Prior to the war about 65 per cent of the domestic output of crude barytes was from Missouri and supplied the mid-western market for ground barytes. It has been estimated that about 50 per cent of the ground barytes manufactured in the mid-western district was prior to the war, and still is, shipped to and consumed in the Atlantic coast market. Foreign competition before the war was chiefly in crude barytes; this is evident from import statistics, which show an importation of only about one-seventh as much ground or manufactured as of crude barytes.

The great increase in the domestic production of crude barytes, beginning in the year 1915, was due partly to the cutting off of the foreign supply of barytes and barium chemicals. War conditions forced eastern manufacturers in the United States to seek a domestic supply of their raw material, and resulted in the establishment in this country of a barium chemical industry. There was also, how-

FIGURE 1 — DOMESTIC CONSUMPTION OF BARYTES BY INDUSTRIES
1915–1919



* 1919 - BASED ON PRELIMINARY FIGURES

C.R.D. 5-28-20.

ever, a natural development due to the increased demand for barytes in the manufacture of lithopone and to the greater use of ground barytes and blanc fixe, particularly in the rubber industry. This increase places the United States second as a producer of crude barytes with an output approaching that of Germany prior to the war.

The domestic output of crude barytes increased about fourfold from 1914 to 1916, or from 52,747 short tons to 221,952 short tons. The 1918 production shows a 25 per cent decrease from the output in 1917. Preliminary figures for 1919 indicate an increase in production to about 190,000 tons. Table 2 shows the domestic sales, imports, and apparent consumption of crude barytes. The same data are shown graphically in Figure 2.

TABLE 2.—*Apparent consumption of crude barytes in the United States, 1910–1919.*

[From Mineral Resources, U. S. Geological Survey.]

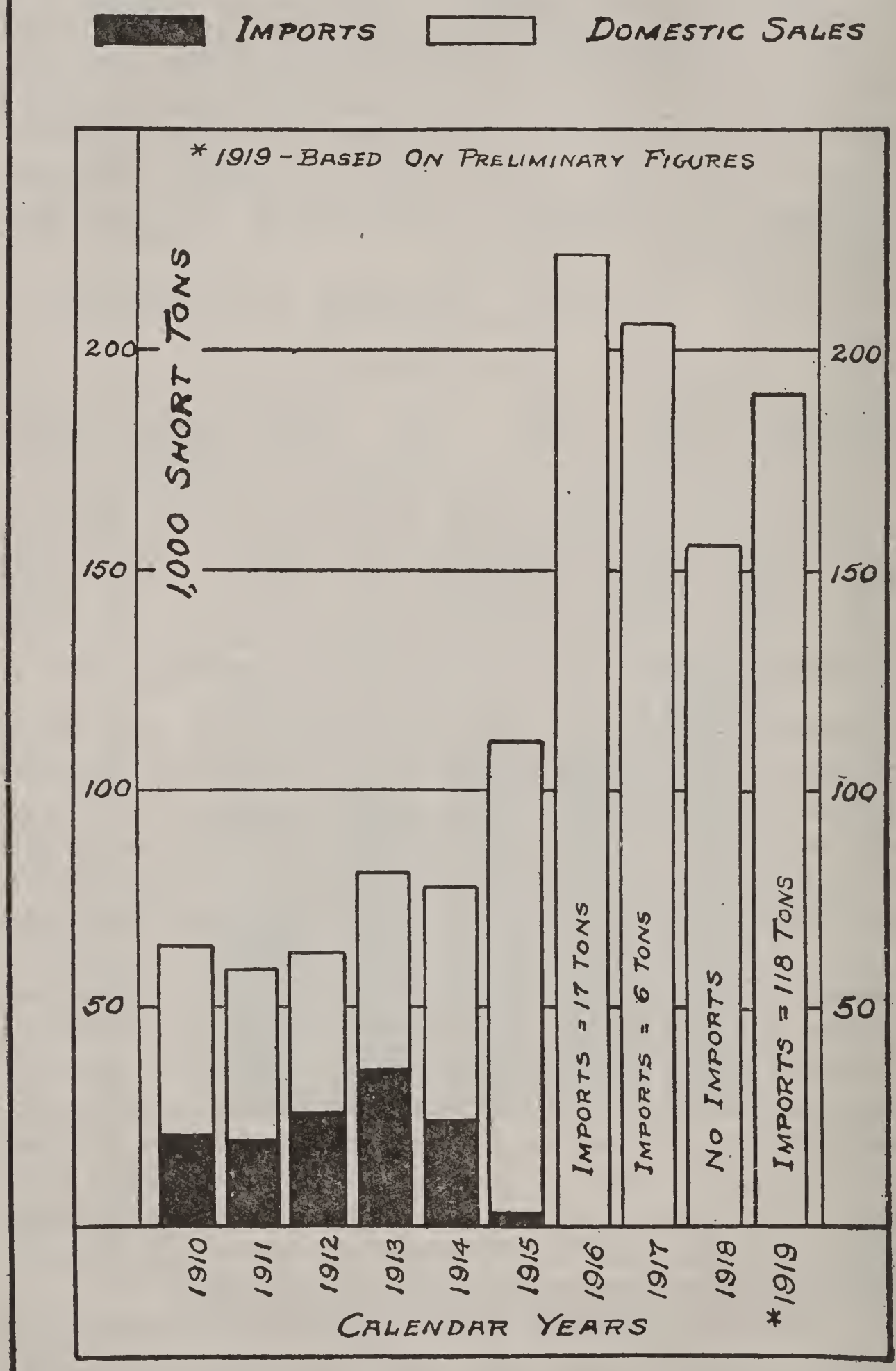
Calendar year.	Sales of domestic barytes.	Imports for consumption.	Apparent consumption.	Calendar year.	Sales of domestic barytes.	Imports for consumption.	Apparent consumption.
	Short tons.	*Short tons.*	*Short tons.*		*Short tons.*	*Short tons.*	*Short tons.*
1910	42,975	21,270	64,245	1915	108,547	2,504	111,051
1911	38,445	20,214	58,659	1916	221,952	17	221,969
1912	37,478	26,186	63,664	1917	206,888	6	206,894
1913	45,298	35,840	81,138	1918	155,368	.....	155,368
1914	52,747	24,423	77,170	1919	[1] 190,000	118	190,118

[1] Preliminary figure furnished by courtesy of the U. S. Geological Survey, subject to revision.

Geographical distribution.—Until 1915 about 65 per cent of the domestic output of crude barytes was mined in the State of Missouri. This location of the domestic barytes mining industry was due, as has been pointed out, to domination of the eastern markets by imported crude barytes. Conditions brought about by war caused a marked change in the domestic industry. In 1915 the output of crude barytes in Georgia about equaled that of Missouri, and in 1916 Georgia became the chief producing State, with a production nearly twice that of Missouri, although the production of Missouri had almost doubled. Since 1915 Georgia has contributed about 50 per cent of the total domestic production. The shifting of the greatest production of crude barytes from Missouri to Georgia was due to the cessation of imports of barytes and barium chemicals from Germany, lower freight rates to eastern factories making lithopone and barium chemicals, and the geological character of the deposits which permitted mining by means of the steam shovel.

War developments, although greatly increasing the output and consumption of crude barytes, still leave the industry divided between two distinct localities—(1) the middle western district, with Missouri as the chief producer, and (2) the southern district, repre-

FIGURE 2.—CONSUMPTION OF BARYTES IN THE UNITED STATES 1910–1919



C.R.D. 5-27-20.

sented chiefly by Georgia and to a lesser extent by Tennessee and Kentucky. The western district supplies lithopone manufacturers in the St. Louis and Chicago districts as well as local manufacturers of ground barytes who ship about one-half of their output into eastern markets. Very little crude barytes from the middle western district is shipped to eastern markets, because of disadvantages as to freight charges. The southern district supplies crude barytes to eastern manufacturers of lithopone who formerly obtained this raw material chiefly from Germany, and also supplies the requirements of the new barium chemical industry which has been developed since the beginning of the war to supply chemicals formerly obtained by importation.

Table 3 shows the production of crude barytes by States since 1910.

TABLE 3.—*Production of crude barytes, by States, 1910–1918.*

[From Mineral Resources, U. S. Geological Survey.

State.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons		*Short tons.*		*Short tons.*	
Missouri	22,978	$75,598	21,500	$81,380	24,530	$117,035
Tennessee	6,503	13,348	8,819	20,053	3,718	8,682
Kentucky						
All other	13,494	32,800	8,126	21,359	9,230	27,596
Total	42,975	121,746	38,445	122,792	37,478	153,313

State.	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Alabama					(1)	(1)
Colorado					(1)	(1)
Georgia					31,027	$102,825
Kentucky					7,753	28,427
Missouri	31,131	$117,638	33,317	$112,231	39,113	158,597
North Carolina					(1)	(1)
Tennessee	2,098	3,568	10,113	16,273	25,074	71,290
All other	12,069	35,069	9,317	27,143	5,580	19,793
Total	45,298	156,275	52,747	155,647	108,547	381,032

State.	1916		1917		1918	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Alabama	7,631	$27,198	1,976	$8,868	1,794	$9,976
Colorado	481	3,005				
Georgia	104,784	401,295	111,300	601,895	69,318	418,178
Kentucky	11,068	54,995	6,720	36,084	(1)	(1)
Missouri	58,223	365,111	59,046	391,363	49,094	393,738
North Carolina	878	3,246	1,019	5,080	(1)	(1)
Tennessee	32,416	123,986	16,972	79,058	22,542	141,844
All other	6,471	32,396	9,855	48,836	12,620	81,169
Total	221,952	1,011,232	206,888	1,171,184	155,368	1,044,905

[1] Included in "All other."

Mining of barytes.—The method of mining crude barytes in the two domestic producing districts varies greatly, although in both the mining is a surface operation. In the Missouri district the mining is all done by pick and shovel, while in the southern district it is largely done by means of steam shovels, which permit of larger-scale operations.

In Missouri the crude barytes or "tiff," which is the local name, is mined chiefly by individuals on a small scale, because of the character of the deposits, which are pockets near the surface and which are scattered over a large area. It is doubtful whether the character of the deposits in Missouri will justify modern methods of mining, such as the use of steam shovel followed by log washing. The general method is to sink a shallow pit about 4 feet in diameter, raise the ore by windlass, and then spread it out to dry in order to loosen adhering clay. The dried ore is then placed in a "rattler," which is a wooden box with holes in the bottom. This removes the clay and small pieces of ore. If the crude barytes has quartz or iron minerals adhering to it, these are removed by hand by means of a small hatchet-like tool. After the ore is cleaned it is placed in stock piles until it can be hauled to the railroad for shipment.

The southern barytes deposits have been developed on a more extensive scale than those of the Missouri district. In many cases the large consumers of crude barytes in the East have developed deposits to supply their own requirements. In all of these large-scale developments the barytes is mined by means of the steam shovel. The barytes deposits in the southern districts, as a rule, are more evenly distributed than in the Missouri district, which permits economical mining by means of steam shovels. Developments on a smaller scale in the southern field involve dry mining with picks and shovels in open cuts. When the steam shovel is used the ore-bearing material is loaded into dump cars and hauled a short distance to the washing plant. Here it is "log washed" to remove clay and earthy impurities. It is then passed over a revolving screen. The small pieces which pass through the screen are "jigged" to remove chert and other foreign minerals, while the large material goes on to a "picking belt," where the foreign rock material is picked out by workmen who stand beside the traveling belt. The washed and cleaned ore is conveyed to storage bins for shipment as crude barytes or is subjected to grinding. The proportion of barytes in ore-bearing material in the southern district usually runs from 20 to 35 per cent.

The difference in the methods used in mining barytes in the Missouri district and the southern district is reflected in the capital investment. In Missouri very little capital outlay is necessary. The equipment required by a miner is simply a pick and shovel and a

windlass. The larger firms, however, have an additional capital investment in houses for the miners, which are furnished free of charge. In the southern district a considerable initial capital investment in steam shovels and washing equipment is necessary before the deposits can be worked economically.

Manufacture of ground barytes.—The preparation of ground barytes varies in the different plants and according to the condition of the crude ore. The general practice, however, is to crush the ore to about 1 inch and by log washing to remove clay and earthy material if the crude ore has not already been treated in this manner. The cleaned material is then ground fine, usually in tube mills. The ground barytes suspended in water is either run over classifying screens or water floated to separate any coarse particles. The finely ground barytes is then usually bleached by washing with sulphuric acid, which removes stains due to oxides of iron. The bleached product is then washed several times with water, after which it is dried, pulverized, and packed either in barrels or bags. Very little labor is used in the process of grinding after the ore is shoveled into the first crusher and until it reaches the packing room. The barytes is conveyed mechanically or pumped suspended in water.

Methods of marketing crude barytes.—The method of marketing crude barytes in the United States varies greatly between the southern and western fields. In Missouri some of the crude barytes (tiff) passes through two and sometimes three hands before it reaches the consumer. The miner sells to a local dealer, usually a storekeeper in return for goods. This buyer sells to a larger buyer having access to the railroad, who in turn sells to the consumer. It is seldom that the consumer deals directly with the miners. In recent years, however, there has been a tendency on the part of the large consumers of barytes in Missouri to buy up the Missouri ore-producing lands. At the present time two St. Louis firms have large holdings in the Missouri fields. These firms have local agents who deal directly with the miners on a tonnage basis. The centralization of the industry thus permits of more direct contact between the consumer and the producer.

In the southern fields the methods of marketing are just the reverse of those in the Missouri fields. Many of the deposits are worked by the manufacturers of barium chemicals and lithopone, although some of them have crude barytes to sell. Many of the miners sell direct to the consumers of crude barytes. This difference is due to the sudden shutting off of imports by the war which forced the eastern manufacturers of barium products to seek a domestic supply and resulted in the development of deposits by the manufacturers themselves.

In the Missouri district crude barytes is sold on the basis of the short ton (2,000 pounds), while in the southern district the long ton (2,240 pounds) is used in all transactions in crude barytes.

Freight rates on crude barytes.[1]—The average freight rate on crude barytes from the Cartersville, Ga., district to eastern lithopone manufacturers is $4.45 per short ton. This average is made up of rates ranging from a low rate of $3.75 to Baltimore, Md., and a high rate of $4.73 to Newark, N. J., Grasselli, N. J., Newport, Del., and Palmerton, Pa.

The average freight rate from the Sweetwater, Tenn., district to eastern lithopone manufacturers is $4.47 per short ton, or practically the same as the average freight rate from the Cartersville district. This average is made up of rates varying from a minimum of $3.75 to Baltimore and a maximum of $4.82 to Newark, Grasselli, and Palmerton. Although the average freight rates from Sweetwater and Cartersville to eastern lithopone manufacturers are practically the same, there is little uniformity in rates to given points. In some cases the rate from Sweetwater is higher than the rate from Cartersville and sometimes lower.

The average freight rate from St. Louis, which may be taken as the shipping point for the Missouri district, to eastern manufacturers of lithopone, is $5.69 per short ton. This, compared with the rates from Cartersville and Sweetwater, gives the southern district an advantage in transportation charges to the eastern lithopone district of $1.24 per short ton. The difference in rates has prevented active competition between southern and western crude barytes in the eastern markets. Missouri ore, in order to compete in these markets, would have to absorb the freight differential of $1.24 in lower prices for crude barytes f. o. b. St. Louis.

Table 4 shows the freight rates on crude barytes from the principal producing points to the principal consuming points.

TABLE 4.—*Freight rates on crude barytes per short ton in carload lots.*

[Compiled from files of Interstate Commerce Commission as of May 26, 1920. Rates are current all rail and commodity rates, unless noted.]

To—	From Cartersville, Ga., minimum carload of 60,000 pounds.	From Sweetwater, Tenn., minimum carload of 60,000 pounds.	From St. Louis, Mo., minimum carload of 40,000 pounds.
Camden, N. J.	$4.29	.....	$5.60
Newark, N. J.	4.73	$4.82	6.00
Grasselli, N. J.	4.73	4.82	6.00
Newport, Del.	4.73	4.29	5.60
Baltimore, Md.	3.75	[2] 3.75	5.40
Palmerton, Pa.	4.73	4.82	5.60
Chicago, Ill.	[3] 5.54	[4] 4.46	2.10
Philadelphia, Pa.	4.29	4.29	5.60

[1] Rates used in this discussion obtaining on May 26, 1920.
[2] From Reagan, Tenn.
[3] Ohio River combination.
[4] Minimum carload weight 44,800 pounds.

Extent of barytes deposits in the United States.—One of the questions of principal importance in considering a duty on barytes is the extent and availability of deposits in the United States. Under the stimulus of war conditions the production of barytes in the United States increased fourfold from 1914 to 1916, and supplied the entire domestic consumption. But there is very little definite information as to the extent of the deposits, and owing to the general nature of the deposits it would be practically impossible to arrive at any accurate estimate of the total domestic barytes resources.

In the absence of official governmental information on the barytes resources of the United States, the Tariff Commission sent out questionnaires to both producers and consumers of barytes requesting information on the extent of domestic deposits. There developed a distinct cleavage of opinion between the two interested groups. The question submitted on the subject was as follows:

> For what length of time do you consider that the barytes resources of the United States are capable of supplying the total domestic requirements? Give your reasons.

Manufacturers of lithopone, the largest consumers of barytes, estimated the life of deposits which are being worked at the present time from a minimum of two years to a maximum of seven years. Lithopone manufacturers were supplied prior to the war with German barytes at a cost less than that of domestic barytes. The following statements are taken from consumers' replies to the above question:

> "A careful review of the different mining sections in the East leads us to believe that the new developed barytes resources are capable of supplying the domestic requirements for not more than two years."
>
> "From five to seven years. This statement is made after a rather exhaustive study of the various barytes producing districts and spending of considerable money in exploration work, and it is believed that practically all of the commercial deposits have been uncovered."
>
> "At present rate of consumption the known higher grade deposits of to-day will be exhausted in from three to five years. Low-grade ores (90 per cent $BaSO_4$) if they can be made suitable, which is questionable, could supply the markets for a longer period (5 to 10 years)."

On the other hand barytes producers state that domestic deposits can supply the demand for an indefinite period. The following replies are quoted from producers of barytes:

> "In the writer's opinion the answer to this question as it stands would be 'indefinitely,' provided the proper stimulus was given. Barytes is one of the most widely distributed mineral substances that we know of. There has, however, up to the last few years been no incentive for the development of American resources, at least in what might be called the eastern seaboard district."
>
> "The fact that several properties have been worked for 15 years past, and are now only developed to a good working basis and are known to be good for 15 to 20 years to come assures us that we are safe as to our supply."

"Unlimited supply in Missouri fields * * *. Portions that have been producing for the past 40 years are still yielding good tonnage, and geologists estimate that the surface ore has only been touched and that heavier deposits lie deeper."

The possibility of increasing the production of barytes is more promising in Georgia and Tennessee than in the Missouri district. The first two districts seem to contain large quantities of ore and could probably be developed to a point where they would supply an increased demand of eastern manufacturers.

Owing to geological and geographical disadvantages, the known domestic deposits in the southern district will probably not be able to compete on even terms in the Atlantic coast market with barytes imported from Germany. The German deposits are of vein formation and require only drilling and blasting to make the ore available for shipment. The known domestic deposits, on the other hand, are of such a character that the ore-bearing material, after mining, requires washing and mechanical separation from foreign rock material—a process which involves additional equipment—before the ore is ready to be marketed as crude barytes. Prior to the war the freight rate from German mines to Atlantic ports was about $3 per ton as compared with the freight rate from Georgia and Tennessee to the eastern markets of about $4.45 a ton. In view of the difference in mining methods and the difference in freight rates, it would appear that competition would be difficult under normal conditions.

In considering a duty on barytes the extent to which the cost of crude barytes enters into the cost of manufactured products should also be taken into account. (See pp. 72 and 87 for further discussion of this phase of the subject.) From the cost figures the effect which a decrease or increase in the cost of barytes would have on the total cost of a particular product can be determined.

PRODUCTION OF BARYTES IN FOREIGN COUNTRIES.

Germany.—Germany has large deposits of crude barytes of an exceedingly good grade and prior to the war was the largest producer of barytes and of barium chemicals. In 1913 she exported 174,235 short tons or nearly four times as much as was produced the same year in this country and three times as much as was produced in the United Kingdom. Her production of crude barytes during 1908 was about 210,000 metric tons (231,000 short tons) valued at around 2,000,000 marks (about $500,000).[1] The exports of Germany as shown by Table 5 increased about 75,000 short tons from 1909 to 1913. This indicates a growth of her output, so it is reasonable to assume that Germany's production of crude barytes just prior to the war was at least 300,000 short tons. The production in the United States during the war increased to a maximum of 221,952 short tons in 1916,

[1] Bartling, Dr. Richard: "Die Schwerspatlagerstaten Deutschlands," 1911.

which gives the United States an output second only to that of Germany.

Table 5, which shows the German exports and imports of barytes and celestite (natural strontium sulphate, which is relatively unimportant in quantity), is indicative of the growth of the industry in that country.

TABLE 5.—*Germany's exports and imports of barytes and celestite.*[1]

[From Vierteljahrshefte zur Statistik des Deutschen Reichs.]

Year.	Exports.		Imports.	
	Short tons.	Value.	Short tons.	Value.
1909	99,819	$705,310	16,049	$104,093
1910	125,962	787,489	6,373	41,209
1911	141,512	788,680	8,737	56,692
1912	157,581	992,818	20,575	133,392
1913	174,235	1,058,084	21,457	139,109

[1] Celestite is naturally occurring strontium sulphate. It is relatively unimportant in quantity compared with barytes so that figures may be taken for all practical purposes as representing barytes.

United Kingdom.[2]—The United Kingdom in 1919 ranked third in the production of crude barytes. In 1913 her production exceeded that of the United States by about 10,000 tons. Production, however, has increased during the war more rapidly in the United States than in the United Kingdom, so that the output in this country in 1917 was almost three times that of Great Britain. The United Kingdom, in addition to having large and valuable deposits of barytes, possesses deposits of witherite (barium carbonate) which can be mined economically. The total annual output of witherite in the United Kingdom since 1880 has varied between 6,000 and 12,000 short tons, the maximum output occurring in 1910. Table 6 gives the production, value at mine, and unit value of crude barytes and witherite produced in the United Kingdom.

TABLE 6.—*Production of barytes and witherite in the United Kingdom.*[3]

Year.	Quantity (short tons).	Value at mine.	Unit value per short ton.	Year.	Quantity (short tons).	Value at mine.	Unit value per short ton.
1900	32,991	$142,316.00	$4.31	1910	$50,027	$213,683.00	4.27
1901	30,927	135,337.00	4.38	1911	49,412	196,538.00	3.98
1902	23,441	109,078.00	4.13	1912	50,822	191,886.00	3.78
1903	27,184	108,620.00	4.00	1913	56,050	205,055.00	3.66
1904	29,486	120,071.00	4.07	1914	54,802	211,722.00	3.86
1905	32,551	144,136.00	4.43	1915	69,974	388,488.00	5.55
1906	40,034	171,700.00	4.29	1916	85,158	620,435.00	7.29
1907	47,011	187,068.00	3.98	1917	73,424	687,797.00	9.37
1908	43,621	171,403.00	3.93	1918	74,323	(4)	(4)
1909	46,778	197,230.00	4.22				

[2] Abstracted from the following official publications of the United Kingdom: Report of the Controller of the Department for Development of Mineral Resources in the United Kingdom, 1918, Cd. 9184; and Carruthers, R. G. et al., Special Reports on the Mineral Resources of Great Britain, Vol. II.—Barytes and Witherite, Memoirs of the Geological Survey of Great Britain.

[3] From Mines and Quarries, Part III, Geenral Report, with Staitstics by Chief Inspector of Mines, Home Office of Great Britain.

[4] Value not available.

The normal annual requirements for crude barium mineral in the United Kingdom amounted to about 100,000 tons. Of this quantity, in normal times, about 60 per cent was imported, chiefly from Germany. Prior to the war little attention was given in the United Kingdom to the proper treatment of the raw barytes. The result was the domination of the British market by Germany, who produced a grade of superior quality as to whiteness and fineness of grinding. Prior to the war the best grade of German ground barytes sold at about 50 shillings ($12.16), and the second grade at 30 shillings ($7.30) per ton delivered in London. A product equal in quality to that formerly imported into the United Kingdom is now being supplied by English manufacturers. A conservative estimate places the quantity of high-grade barytes ore "in sight" in 1918 in the United Kingdom at 500,000 tons, which is equivalent to a five-year supply. There are, however, many large and undeveloped deposits in both England and Ireland, so that requirements of the United Kingdom can be supplied for many years.

About 70 per cent of the barytes consumed in the United Kingdom is used in the manufacture of lithopone and paints. The remainder is used in paper, rubber, and linoleum manufacture. Witherite is used chiefly by chemical manufacturers in the production of barium chemicals.

Table 7 gives the production, imports, exports, and apparent consumption of barytes in the United Kingdom:

TABLE 7.—*Apparent consumption of barytes in the United Kingdom.*

Calendar year.	Production.	Imports.[1]	Exports.[1]	Apparent consumption.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*
1910	50,027	50,876	12,874	88,029
1911	49,412	54,054	9,432	94,034
1912	50,822	64,412	9,933	105,301
1913	56,050	61,188	6,425	110,813
1914	54,802	35,379	3,337	86,844
1915	69,974	7,937	2,748	75,163
1916	85,158	10,343	4,733	90,768
1917	73,424	1,566	4,207	70,783
1918	74,323	1,658	1,757	74,224
1919	.....	22,972	1,360	.....
1920 (5 months)	.....	13,271	317	.....

[1] From the Annual Statement of the Trade and Commerce of the United Kingdom.

Other foreign countries.[2]—Other foreign countries which produce barytes in appreciable quantities are Belgium, Spain, France, and Italy. The output of Belgium has varied considerably, but may be taken as between 20,000 and 30,000 tons. The production of Italy increased during the war from 13,000 tons in 1914 to about 19,000 tons in 1917. The production of France prior to the war was about

[2] Figures of production from Mineral Industry, New York, 1918.

12,000 tons; statistics for later years are not available. The output of barytes in Spain increased from 4,000 tons in 1915 to about 10,000 tons in 1917.

IMPORTS INTO THE UNITED STATES.

The imports of crude barytes were increasing prior to the war, and in 1914 amounted to 36,456 short tons, valued at $63,260. The imports of ground or manufactured barytes were considerably less and in 1914 had reached 6,026 short tons, valued at $42,625. Imports, which were almost wholly from Germany, were shut off with the outbreak of the war, and there have been practically no imports of barytes since 1915.

Tables 8 and 9 show the imports for consumption of crude and ground barytes since 1910.

TABLE 8.—*Imports of crude barytes for consumption in the United States, 1910–1919.*

[Baryta, sulphate of, or barytes, including barytes earth, unmanufactured.]

Fiscal year.	Rate of duty.	Quantity (short tons).	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1910 [1]	75 cents per ton	2,500	$10,824	$1,674	$4.33	15.47
1910 [2]	$1.50 per ton	9,395	21,286	12,582	2.27	59.11
1911	do	20,602	45,06.	27,592	2.19	61.23
1912	do	23,507	40,941	31,482	1.74	76.90
1913	do	31,761	63,345	42,537	1.99	67.15
1914 [3]	do	6,680	12,313	8,946	1.84	72.65
1914 [4]	15 per cent. ad valorem	29,776	50,947	7,642	1.71	15.00
1915	do	10,770	21,087	3,163	1.96	15.00
1916	do	17	245	37	14.41	15.00
1917	do	.....	.....	.....	.....	.....
1918	do	6	63	9	10.50	15.00
1919	do	39	245	37	6.28	15.00

[1] From July 1 to Aug. 5, 1909.
[2] From Aug. 6, 1909, to June 30, 1910.
[3] From July 1 to Oct. 3, 1913.
[4] From Oct. 4, 1913, to June 30, 1914.

TABLE 9.—*Imports of ground barytes for consumption in the United States, 1910–1919*

[Baryta, sulphate of, or barytes, including barytes earth, manufactured.]

Fiscal year.	Rate of duty.	Quantity (short tons).	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
						Per cent.
1910	$5.25 per ton	3,023	$27,191	$14,169	$8.99	52.11
1911	do	3,655	26,462	17,131	7.24	64.74
1912	do	3,012	21,642	14,117	7.19	65.23
1913	do	5,145	36,819	24,119	7.16	65.51
1914 [1]	do	1,107	7,520	5,184	6.79	68.94
1914 [2]	20 per cent ad valorem	4,919	35,105	7,021	7.14	20.00
1915	do	1,966	14,997	2,999	7.63	20.00
1916	do	.....	2	.....	.....	20.00
1917	do	235	3,813	763	16.23	20.00
1918	do	.....	.....	.....	.....	20.00
1919	do	.....	.....	.....	.....	20.00

[1] From July 1 to Oct. 3, 1913.
[2] From Oct. 4, 1913, to June 30, 1914.

PRICES.

United States.—The average dutiable value of crude barytes imported from 1912 to 1915, inclusive, was $1.85 per short ton, as shown by import statistics. Information from consular invoices shows that the prewar price of crude barytes was about $1.75 per short ton f. o. b. German mines. Freight charges from the mine to Atlantic ports made the price of crude barytes about $4.70 per short ton ex ship at New York or Philadelphia. To this price must be added the duty under the act of 1913 and barge or switching charge to eastern consumers, so that the price delivered at plants was about $5.20 per short ton. This price varied somewhat according to individual conditions, but the figures given may be taken as an average. Table 10 shows the detail of the price of imported crude barytes for 1914:

TABLE 10.—*Average price per short ton of crude barytes imported from Germany,*[1] *1914.*

Price f. o. b. mine	$1.75
Railroad and river freight to Rotterdam	1.20
Ocean freight	1.75
Price ex ship New York or Philadelphia (duty not paid)	4.70
Price delivered at plants on Atlantic coast[2]	5.20

The price of domestic crude barytes f. o. b. St. Louis has about doubled during the war. The price from May, 1913, until November, 1915, varied very little from $4.90 per short ton. The price then increased to $9.80 per ton in October, 1918, and this price was in force until May, 1919, when it decreased to $8.80 per ton. In November, 1919, the price increased sharply to $10.80 per ton. Table 11 shows the market price of crude barytes per short ton f. o. b. Missouri shipping points.

TABLE 11.—*Market price of crude barytes f. o. b. Missouri shipping points.*

[Dollars per short ton.]

Date.	Washington County, Mo., district.	St. Louis, western Missouri district.
1912, January to October	$4.25	$4.90
1912, October to December, inclusive	5.50	6.15
1913, January to May	7.00	7.65
1913, May to December, inclusive	4.25	4.90
1914, entire year	4.25	4.90
1915, January to November	4.25	4.90
1915, November and December	4.50	5.15
1916, January	4.50	5.15
1916, February and March	5.00	5.65
1916, April to December, inclusive	7.00	7.65
1917, entire year	7.00	7.65
1918, January to August	7.00	7.80
1918, August and September	8.00	8.80
1918, October to December, inclusive	9.00	9.80
1919, January to May	9.00	9.80
1919, May to November	8.00	8.80
1919, November and December	10.00	10.80
1920, January to April	10.00	10.80

[1] From consular invoices of individual shipments.

[2] Includes duty under the act of 1913 and barge or switching charge to plant.

Contract prices on Missouri ground barytes f. o. b. St. Louis have not increased in the same ratio as crude barytes. Table 12 shows contract prices of ground barytes f. o. b. St. Louis in carload shipments.

TABLE 12.—*Contract price of Missouri ground barytes f. o. b. St. Louis in carload shipments.*

Year.	Per short ton.	Year.	Per short ton
1912	$13.00	1917	$19.00
1913	15.50	1918	19.00
1914	13.00	1919	21.50
1915	13.00	1920	21.50
1916	13.00		

The price of crude barytes f. o. b. Cartersville, Ga., increased from $4.25–$6.00 per short ton in 1916 to $8.95 per short ton in the first half of 1920. The price of ground barytes f. o. b. Cartersville has been more constant than that of crude barytes. The price of ground barytes was $17.85 per short ton from 1916 to 1918, inclusive, and then increased to $18.75 in 1919 and the first part of 1920. Table 13 shows the price of crude and ground barytes f. o. b. Cartersville, Ga., since 1916:

TABLE 13.—*Prices of crude and ground barytes per short ton f. o. b. Cartersville, Ga.*

Year.	Crude.	Ground.
1916	$4.25–$6.00	$17.85
1917	4.90– 6.70	17.85
1918	6.45– 8.00	17.85
1919	7.35– 8.95	18.75
1920	8.95	18.75

United Kingdom.—Price quotations on crude barytes in the United Kingdom are not available. Table 6, which gives the production of crude barytes in the United Kingdom shows an average reported value of $3.86 per short ton in 1914, which increased to $9.37 in 1917, the latest year for which complete statistics are available. The increase in the price of ground barytes in the United Kingdom during the war was about in the same proportion as in this country. The increase, however, began in 1912 and shows a gradual trend upward from that time, while the increase in price in the United States did not begin until 1916. The price in the United Kingdom has usually been lower than the price in this country. Table 14 shows the price of ground barytes by quarters in the United Kingdom as quoted by the Chemical Trade Journal and Chemical Engineer of London.

TABLE 14.—*Price of ground barytes in the United Kingdom, 1910–1919; per short ton.*[1]

1910—January	$9.77–$14.12	1915—January	$16.29–$19.55
April	9.77– 14.12	April	17.38– 20.63
July	9.77– 14.12	July	18.46– 21.72
October	9.77– 14.12	October	19.55– 26.06
1911—January	9.77– 14.12	1916—January	19.55– 26.06
April	9.77– 14.12	April	19.55– 26.06
July	9.77– 14.12	July	19.55– 32.58
October	9.77– 14.12	October	19.55– 32.58
1912—January	9.77– 14.12	1917—January	19.55– 32.58
April	9.77– 14.12	April	21.72– 36.92
July	10.86– 14.12	July	21.72– 36.92
October	10.86– 14.12	October	21.72– 36.92
1913—January	11.95– 16.29	1918—January	21.72– 36.92
April	13.03– 16.29	April	30.41– 60.83
July	13.03– 16.29	July	30.41– 60.83
October	13.03– 16.29	October	39.10– 65.18
1914—January	13.03– 16.29	1919—January	39.10– 65.17
April	13.03– 16.29	April	39.10– 65.17
July	13.03– 16.29	July	30.42– 60.83
October	16.29– 19.55	October	30.42– 60.83

[1] Taken from Chemical Trade Journal and Chemical Engineer, London. Listed as barium sulphate, native levigated, f. o. r. at works or usual ports of shipment.

Germany.—Barytes is not regularly quoted in German chemical trade journals. The following prices are offerings of crude and ground barytes, which were received by American firms from German firms.[1] The prices quoted in these letters are tabulated and converted in Tables 15 and 16 at the par value of the mark and at the exchange value of the mark on the date the letters were written.

TABLE 15.—*Prices of crude barytes, free Hamburg or Bremen, Oct. 21, 1919.*

Grade.	Price per short ton.		
	Marks.	Mark = $0.2382.	Mark = $0.036.
No. 1 = 98 to 99 per cent	65	$15.48	$2.34
No. 2 = 95 to 96 per cent	60	14.29	2.16

TABLE 16.—*Price of crude barytes, free Bremen, Hamburg, or Rotterdam, Sept. 30, 1919.*

Brand.	Class.	Price.		
		Marks per metric ton.	Dollars per short ton.	
			Mark = $0.2382.	Mark = $0.04.
S W O O O	1	329.5	$71.20	$11.96
Lowe	3	318.5	68.83	11.56
Adler	6	304.5	65.80	11.05
G O O O	8b	292.5	63.21	10.61

[1] Original letters in files of the Tariff Commission.

COMPETITIVE CONDITIONS.

The situation prior to the war.—The Atlantic coast market for crude barytes was supplied exclusively by imports, chiefly from Germany, amounting to between 35 and 45 per cent of the total domestic consumption of crude barytes. The interior points at which imported barytes could compete with the domestic ore produced in Missouri depended wholly on the cost of transportation or freight rates to the market in question. The outlet for domestic crude barytes prior to the war was thereby restricted to supplying the middle western manufacturers of ground barytes, while the imported crude barytes was consumed almost wholly by eastern manufacturers of lithopone.

This division of the domestic market did not exist in the case of ground barytes. Under the duties in the act of 1909 for ground or manufactured barytes ($5.25 per ton), domestic ground barytes was able to compete in the Atlantic coast market with imported ground barytes. It is estimated that prior to the war about 50 per cent of the ground barytes manufactured in the Middle West was shipped to and consumed in the Atlantic coast market. The imports of ground or manufactured barytes prior to the war were only about 15 per cent of the imports of crude barytes, which shows that the competition between domestic and foreign barytes was chiefly in the crude ore. Table 17 shows the imports of ground and crude barytes for 1911 to 1913, inclusive.

TABLE 17.—*Comparison of imports of crude and ground barytes, 1911–1913.*

Fiscal year.	Ground barytes.	Crude barytes.
	Short tons.	*Short tons.*
1911	3,655	20,602
1912	3,012	23,507
1913	5,145	31,761

The present situation.—The deposits of barytes in the southern district have an advantage over Missouri deposits of about $1.25 per short ton in freight rates to the Atlantic coast market. War conditions have therefore not changed the competitive situation as far as middle western producers of crude barytes are concerned. With normal conditions restored competition in crude barytes in the Atlantic coast market will be between the foreign product and domestic crude barytes produced in Georgia, Tennessee, and Kentucky; crude barytes produced in Missouri will not be able to compete in this market even under existing conditions.

In the matter of ground barytes, however, the manufacturers in the Middle West continue to ship about 50 per cent of their product

to the Atlantic coast market. Although ground barytes from the southern district has a lower freight rate to Atlantic coast markets than Missouri ground barytes, the Missouri product still supplies a large portion of this market. This may be explained by the fact that eastern lithopone and barium chemical manufacturers developed the southern deposits chiefly to supply their raw-material requirements. Missouri barytes is a softer variety and is better adapted for the manufacture of ground barytes than is the southern ore. It is evident that the producers of crude barytes in the southern district are particularly interested in retaining the Atlantic coast market for crude barytes while the Missouri producers and manufacturers of ground barytes are more interested in being able to hold this market for ground barytes, which they largely supplied prior to the war.

TARIFF HISTORY.

Barytes or barium sulphate, unmanufactured or manufactured, has been dutiable since the passage of the act of 1883, with the exception of the period covered by the act of 1894, when barytes unmanufactured, including barytes earth, was free of duty. Witherite (natural barium carbonate) has uniformly been exempt from duty since 1883. The duties levied on barytes, unmanufactured and manufactured, and the provisions for witherite beginning with the act of 1883 are as follows:

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	40	Baryta, sulphate of, or barytes, unmanufactured	10 per cent ad valorem.
1883	41	Baryta, sulphate of, or barytes, manufactured	¼ cent per pound.
1883	603	Baryta, carbonate or witherite	Free.
1890	49	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured	$1.12 per ton.
		Manufactured	$6.72 per ton.
1890	500	Baryta, carbonate of, or witherite	Free.
1894	37	Baryta, sulphate of, or barytes, manufactured	$3 per ton.
1894	395	Baryta, carbonate of, or witherite, and baryta, sulphate of, or barytes, unmanufactured, including barytes earth.	Free.
1897	44	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured	75 cents per ton.
		Manufactured	$5.25 per ton.
1897	489	Baryta, carbonate of, or witherite	Free.
1909	42	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured	$1.50 per ton.
		Manufactured	$5.25 per ton.
1909	711	Witherite	Free.
1913	51	Baryta, sulphate of, or barytes, including barytes earth:	
		Unmanufactured	15 per cent ad valorem.
		Manufactured	20 per cent ad valorem.
1913	646	Witherite	Free.

CONSTRUCTION OF THE LAW.

In a case under the act of 1894 in which the importers furnished no evidence to support their protest, ground carbonate of baryta was held dutiable as an unenumerated manufactured article and not

exempt from duty as native or unmanufactured carbonate of baryta or witherite of commerce. (G. A. 3622, T. D. 17483.) Under the act of 1897 which removed the limitation to carbonate of baryta in its unmanufactured condition, ground carbonate of baryta was held exempt from duty. (G. A. 4243, T. D. 19947.) In a court decision likewise classifying precipitated carbonate of baryta, paragraph 489 of the act of 1897 was declared not limited to the particular kind of carbonate of baryta known as witherite, but included all carbonates of baryta whether or not known by the name of witherite. (Gabriel & Schall *v.* United States, 121 Fed., 208; followed by the Board of General Appraisers in G. A. 5314, T. D. 24331, and G. A. 7141, T. D. 31145.) A like conclusion was reached by the Court of Customs Appeals. (United States *v.* Gabriel & Schall, 1 Ct. Cust. Appls., 90.) The provision for "witherite" in paragraph 711 of the act of 1909 was, however, declared to be limited to the natural crude mineral ore and not inclusive of precipitated carbonate of baryta, which, being a chemical salt, was held dutiable under paragraph 3 of that act. (G. A. 7262, T. D. 31810.)

PART III

THE BARIUM CHEMICAL INDUSTRY

PART III.

THE BARIUM CHEMICAL INDUSTRY.

DESCRIPTION AND USES.

The term "barium chemicals" is used in this report to include various barium salts or compounds which are manufactured by chemical processes from the barium minerals, barytes and witherite.

Blanc fixe or artificial sulphate of barytes, as it is described in the tariff act of October 3, 1913, is barium sulphate which has been precipitated from a solution of a soluble barium salt by means of a sulphate, usually salt cake. The term "blanc fixe," which means permanent white, is generally used in commerce to designate this article. The term "precipitated barium sulphate" describes the product much more accurately than artificial sulphate of barytes. As the term "barytes" alone signifies barium sulphate, the phrase "sulphate of barytes" is redundant. Blanc fixe is the best grade of barium sulphate for pigment purposes, both as to whiteness and fineness of the product. In chemical composition blanc fixe is practically identical with natural ground barytes, but its physical properties are different. The two products should not be confused. Blanc fixe is largely used where a pure white pigment or filler is desired, as in paints, rubber goods, linoleum, oilcloth, and glazed paper. It is also used in lithographic inks, as a base for lake colors, and is used extensively as a pigment by the United States Navy in "battleship gray," which contains about 45 per cent of blanc fixe. Blanc fixe under the name of chemically pure barium sulphate is used as an indicator in X-ray photography. It is placed on the market in pulp and as a dry powder. The pulp is a paste containing about 30 per cent of water and is used chiefly by the paper and lithographic ink manufacturers. The dry powder is used for pigment purposes.

Barium carbonate is a white insoluble barium salt prepared by precipitation from a solution of barium sulphide with soda ash. Its largest use is in the ceramics industry for the manufacture of optical glass, for which purpose a chemically pure product is required. Recently it has assumed importance in the manufacture of flat wall paints, and this use will undoubtedly increase. These

paints when containing about 45 per cent of precipitated barium carbonate produce a velvety finish. Witherite (natural barium carbonate) can not be used for this purpose and should not be confused with precipitated barium carbonate. It is also used as the raw material for making barium peroxide and in the manufacture of some kinds of enameled iron ware.

Barium chloride is a white barium salt which is fairly soluble in water. It crystallizes with two molecules of water and is usually sold in the crystalline or powdered form. It is largely used in the manufacture of blanc fixe and of color lakes as a mordant for fixing acid dyes on the inert base, such as aluminum hydroxide or blanc fixe. Barium chloride is also used in the purification of salt, as a water softener, a chemical reagent in sulphur determinations, to some extent in the ceramics industry, and in the manufacture of certain photographic chemicals. It has certain medicinal uses.

Barium nitrate is a soluble barium salt used principally for making barium peroxide or dioxide. It is also used in pyrotechnics for making green fire and green signal lights and in the manufacture of certain explosive mixtures, thus giving barium nitrate some military significance. It also has certain medicinal uses similar to barium chloride.

Barium monoxide or baryta has its chief use as an intermediate product in the preparation of the binoxide or peroxide of barium. It is also used in the manufacture of certain varieties of optical glass. In European countries, especially Germany, it is used in refining beet sugar.

Barium hydroxide, hydrate of baryta, or caustic baryta, has very little commercial use in the United States. During the period of high prices for caustic potash, barium hydroxide was used to convert sulphate of potash into caustic potash. In Europe it is used with barium monoxide in the refining of beet sugar.

Barium binoxide, barium dioxide, or barium peroxide, is used chiefly for the manufacture of hydrogen peroxide. It is also used for the production of oxygen and as a bleach, especially in the blanket and straw hat industries. Large quantities of hydrogen peroxide were required for war purposes. This demand and the use of barium peroxide in tracer bullets resulted in a large increase in production.

Barium sulphide is the intermediate barium compound from which the majority of the other barium chemicals are made and is one of the necessary materials in the manufacture of lithopone. It is also used with lime as a depilatory in leather manufacture. Crude barium sulphide, which is made by roasting barytes with coal, is known as "black-ash."

Barium chromate or lemon yellow, or yellow ultramarine, is used as a yellow pigment.

Barium chlorate is used in pyrotechnics and in dyeing.

DOMESTIC PRODUCTION.

Production and consumption.—Prior to the war the United States was almost wholly dependent on imports for its supply of barium chemicals. There was practically no domestic production of the barium salts such as barium dioxide, chloride, nitrate, and blanc fixe. The only product manufactured in this country on a large scale prior to the war, which utilized barytes as a raw material, was lithopone, which is discussed on pages 53–60.

The shutting off of imports with the outbreak of the war gave a great stimulus to the establishment of a barium chemical industry in the United States. In addition there were large war demands for certain barium salts (barium peroxide, blanc fixe, and barium nitrate) which greatly increased the domestic production and tended to develop an industry in the United States. Plants for the manufacture of barium salts have been located chiefly in the eastern and southern sections of the United States. The southern plants are located in close proximity to the raw material barytes. There are also plants located in Ohio and Illinois. The following is a list of the principal manufacturers of barium chemicals in the United States:

Alton Chemical Corporation, Alton, Ill.
Chicago Copper & Chemical Co., 111 West Jackson Boulevard, Chicago, Ill.
Consolidated Chemical Products Co., Alton, Ill.
Durex Chemical Corporation, 320 Fifth Avenue, New York City. (Plant at Sweetwater, Tenn.)
E. I. du Pont de Nemours & Co., Wilmington, Del.
J–H–R. Products Co., Willoughby, Ohio.
Oakland Chemical Co., 10 Astor Place, New York City.
Rollin Chemical Corporation, 120 Broadway, New York City. (Plant at Charleston, W. Va.)

The production of barium chemicals has increased steadily from 17,646,000 pounds in 1915 to 46,372,000 pounds in 1918. Preliminary figures furnished by the Geological Survey indicate a total production of barium chemicals during 1919 of about 41,500,000 pounds. The order of the barium salts according to quantity of production during 1918 was blanc fixe, barium carbonate, and barium chloride. Table 18 shows the domestic output of barium chemicals, beginning with 1915.

TABLE 18.—*Production of barium chemicals in the United States, 1915–1918.*

[From Mineral Resources, United States Geological Survey.]

	1915	1916	1917	1918
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Barium binoxide	(1)	3,960,000	(1)	(1)
Barium carbonate	5,492,000	13,688,000	16,476,000	15,322,000
Barium chloride	4,212,000	7,286,000	9,740,000	9,060,000
Barium nitrate	1,942,000	892,000	330,000	(1)
Barium sulphate or blanc fixe	(1)	6,674,000	12,628,000	19,044,000
All others	6,000,000	1,084,000	5,832,000	2,946,000
Total	17,646,000	33,584,000	45,006,000	46,372,000

[1] Included in "All others."

Process of manufacture.—Barytes is the raw material used in the United States for the manufacture of barium chemicals with the exception of a small quantity of witherite which is imported. A deposit of witherite was discovered in California in 1914, but it has not proved to be of commercial importance.

The manufacturers of barium chemicals prefer to use the washed, high-grade barytes of the soft type, but they can and do use the barytes which could not be used in the preparation of the highest grades of ground barytes. The crude barytes is first crushed and mixed with the proper proportions of pulverized coal. The proportion of barytes and coal varies slightly with individual manufacturers; it is generally one part of coal to four parts of barytes by weight. This mixture is roasted for about four hours in a rotating reduction furnace. The barium sulphate is reduced by the coal to barium sulphide during the roasting. The crude barium sulphide (black ash), which contains about 70 per cent of barium sulphide, is then treated with hot water and a solution of barium sulphide is thereby formed. This solution is used as the starting point for the preparation of the barium chemicals and also in the manufacture of lithopone. (See p. 54.)

Barium carbonate is precipitated from a solution of barium sulphide by treatment with sodium carbonate (soda ash). Sodium sulphide is obtained as a by-product. It can also be prepared by passing a current of carbon dioxide gas through the solution of barium sulphide. By this last process, sodium sulphide is not obtained as a by-product.

The method of producing *blanc fixe* or precipitated barium sulphate depends on the physical properties which are desired for the finished product. It was formerly made only by treating a solution of barium chloride with sodium sulphate or sulphuric acid. It is now usually made by precipitation from a solution of barium sulphide by means of salt cake (sodium sulphate). This method produces a much denser product than that produced from barium chloride, and in addition yields sodium sulphide as a valuable

by-product. It is also made as a by-product of the manufacture of hydrogen peroxide when barium peroxide is treated with sulphuric acid. For certain color purposes blanc fixe is precipitated from hot,

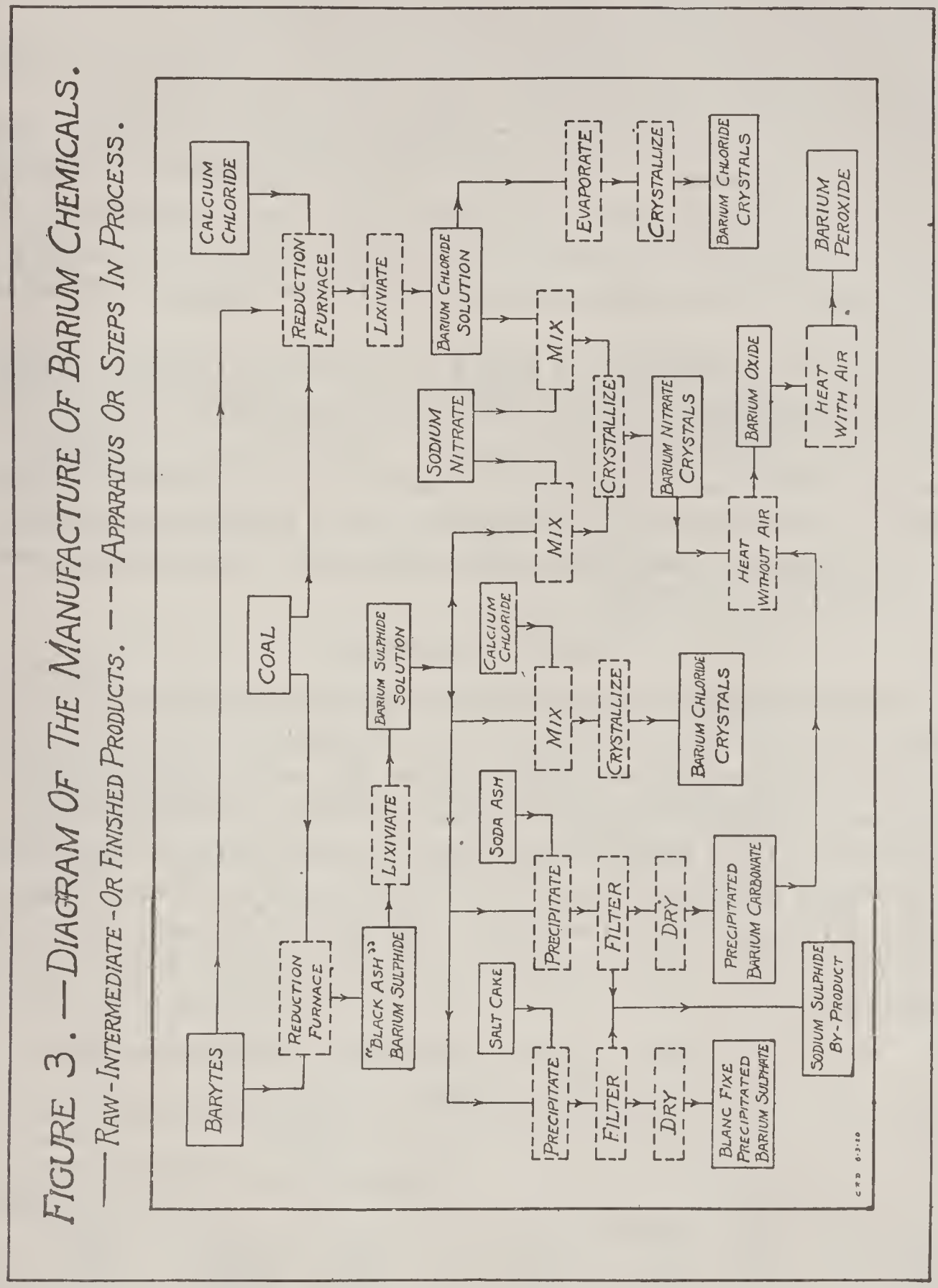


FIGURE 3.—DIAGRAM OF THE MANUFACTURE OF BARIUM CHEMICALS.
—RAW-INTERMEDIATE-OR FINISHED PRODUCTS. ---APPARATUS OR STEPS IN PROCESS.

concentrated solutions, thus giving a crystalline product which is a valuable base for the manufacture of very brilliant colors.

Barium chloride may be produced by treating witherite (barium carbonate) with hydrochloric acid. It is usually produced in this country directly from crude barytes by roasting with coal and calcium chloride. It may also be prepared by treating a solution of barium sulphide with calcium chloride.

Barium nitrate is produced by adding sodium nitrate (Chile saltpeter) either to a solution of barium chloride or to a solution of barium sulphide. It is also produced by dissolving witherite in a solution of nitric acid. The barium nitrate thus produced can be converted into barium oxide, dioxide, or hydroxide.

Barium chromate is prepared by treating a solution of barium chloride or other soluble barium salts with sodium chromate.

Barium peroxide or dioxide is prepared from either barium nitrate or barium carbonate. The barium nitrate or carbonate is first converted into barium oxide by heating in a closed apparatus. The barium oxide is then converted into barium peroxide by heating at about 700° C. in a current of air free from carbon dioxide and moisture.

Whenever a sodium salt is added to a solution of barium sulphide in the preparation of barium salts there is produced, in addition to the desired barium product, sodium sulphide as a valuable by-product. This is an important product of the barium chemical industry, and has a large consumption by the American dye industry in the preparation of sulphur colors, especially sulphur black, which is used in large quantities.

FOREIGN PRODUCTION.

Although statistics are not available on the production of barium chemicals in foreign countries, it is undoubtedly true that Germany was the largest single producer prior to the war. England, France, and Italy possessed smaller barium chemical industries, and the industries in these countries have also been stimulated by war conditions which prevented exports of barium products from Germany. Table 19, which shows Germany's exports and imports of barium chemicals, indicates the importance of the German industry prior to the war.

TABLE 19.—*Germany's exports and imports of barium chemicals.*

[From Vierteljahrshefte zur Statistik des Deutschen Reichs.]

	Exports.		Imports.	
	Short tons.	Value.	Short tons.	Value.
Blanc fixe, precipitated barium sulphate:				
1909	5,388	$98,853	15	$238
1910	6,093	111,954	20	476
1911	7,548	197,706	6	238
1912	9,147	222,955	7	238
1913	8,418	219,859	6	.....
Barium chloride:				
1909	5,865	126,722	2,012	43,114
1910	7,114	153,639	2,155	44,305
1911	6,812	154,830	2,217	45,496
1912	8,145	165,787	4,050	78,844
1913	6,227	135,059	2,863	58,835
Barium nitrate:				
1909	676	46,687	.....	.....
1910	1,088	72,889	.....	.....
1911	1,022	67,887	2	238
1912	893	62,885	3	238
1913	1,445	104,570	15	953

IMPORTS INTO THE UNITED STATES.

The imports of all barium chemicals (exclusive of lithopone and blanc fixe) in 1914 were 19,299,702 pounds, valued at $526,824. Of this quantity about 66 per cent came from Germany. About 90 per cent of the importation in 1914 was represented by three barium salts, namely, precipitated barium carbonate, barium chloride, and barium dioxide. Table 20 shows the detail of the imports of barium chemicals in 1914 with countries of origin:

TABLE 20.—*Imports of barium chemicals by countries, fiscal year 1914.*[1]

Article.	Quantity.	Value.	Per cent of quantity, by countries.	
Barium:				
Carbonate (precipitated)	*Pounds.* 5,131,339	$47,648	Germany	80.6
			Belgium	11.9
			England	7.5
Chlorate—				
Commercial crystals	17,680	752	Switzerland	74.4
			England	25.6
Depurative	159	4	Germany	100.0
Chloride	6,118,387	65,443	....do	70.4
			Austria-Hungary	29.6
Dioxide (binoxide)	6,085,909	330,142	Germany	45.8
			England	42.0
			Belgium	12.2
Hydroxide—				
Commercial crystals	104,790	1,612	Germany	95.4
			England	4.0
			Belgium	.6
Chemically pure crystals	148	11	Germany	100.0
Pure exsiccated	2,555	401	....do	100.0
Hypophosphite	113	117	England	99.1
			Germany	.9
Nitrate—				
Crystals	1,040,772	38,728	....do	98.7
			Belgium	1.1
			England	.2
Powder, fused	2,200	411	Germany	100.0
Oxide—				
Hydrated, commercial crystals	3,047	96	....do	100.0
Hydrated, caustic, chemically pure exsiccated.	11	2	....do	100.0
Anhydrous chemically pure	4	2	....do	100.0
Peroxide—				
Anhydrous commercial powder	707,440	35,423	....do	50.4
			England	27.1
			Belgium	22.5
Pure hydrated	24	5	Germany	100.0
Sulphide—				
Crude lumps	12,373	930	....do	100.0
Purified	9,360	893	....do	100.0
Pure	622	148	....do	100.0
Sulphite	837	731	....do	100.0
Sulfo cyanide	61,932	3,325	....do	97.0
			Canada	3.0
Total	19,299,702	526,824		

[1] Pickrell, Dr. E. R.: Chemicals and Allied Products Used in the United States, Department of Commerce, Miscellaneous Series No. 82.

Imports for consumption.—The imports of barium chemicals have practically ceased since 1915 owing to the severance of trade with Germany which was the chief source of supply. The imports of

practically all the barium chemicals prior to the war had increased to a maximum in 1914. The imports of barium chloride during the last six months of the 1919 calendar year (not shown in Table 21) were 1,096,396 pounds, valued at $19,063. This is the first barium chemical to be imported since the war in anything like the quantity of prewar imports. Table 21 shows the imports for consumption of the most important barium chemicals since 1910:

TABLE 21.—*Imports of barium chemicals for consumption in the United States.*

BARIUM CARBONATE, PRECIPITATED.

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1912	25 per cent	946,971	$7,376	$1,844	$0.008	25.00
1913	do	2,182,517	20,143	5,035	.009	25.00
1914[1]	do	485,889	4,384	1,096	.009	25.00
1914[2]	15 per cent	4,509,562	42,041	6,306	.009	15.00
1915	do	344,588	7,864	1,179	.023	15.00
1916	do	6	2		.333	15.00
1917	do	804	177	26	.220	15.00
1918	do	106,288	1,437	215	.014	15.00
1919	do					

BARIUM CHLORIDE.

1910	25 per cent	3,705,502	$33,672	$8,418	$0.009	25.00
1911	do	2,742,486	29,771	7,442	.011	25.00
1912	do	2,834,980	27,766	6,941	.010	25.00
1913	do	2,926,159	26,341	6,585	.009	25.00
1914[1]	do	254,106	2,558	639	.010	25.00
1914[2]	¼ cent per pound	5,856,280	62,005	14,640	.011	23.61
1915	do	4,686,029	60,532	11,715	.013	19.35
1916	do	50	10		.200	1.30
1917	do	6,614	608	16	.092	2.72
1918	do					
1919	do	3,290	783	8	.238	1.05

BARIUM DIOXIDE OR BINOXIDE.

1910	25 per cent	3,563,528	$261,674	$65,418	$0.073	25.00
1911	do	4,896,563	347,129	86,782	.071	25.00
1912	do	3,715,823	255,053	63,763	.069	25.00
1913	do	3,507,508	215,500	53,875	.061	25.00
1914[1]	do	882,385	49,611	12,402	.056	25.00
1914[2]	1½ cents per pound	5,203,413	280,528	78,051	.054	27.82
1915	do	4,084,144	317,262	61,262	.077	19.31
1916	do	546,442	48,451	8,196	.088	16.92
[3]						

BLANC-FIXE OR ARTIFICIAL SULPHATE OF BARYTES, AND SATIN WHITE OR ARTIFICIAL SULPHATE OF LIME.

1910	½ cent per pound	5,656,507	$66,923	$28,282	$0.012	42.26
1911	do	6,332,699	73,278	31,663	.012	43.07
1912	do	5,702,262	70,925	28,511	.012	40.20
1913	do	4,808,726	58,499	24,043	.012	41.10
1914[1]	do	1,166,525	16,837	5,832	.014	34.72
1914[2]	20 per cent	3,585,949	43,804	8,760	.012	20.00
1915	do	2,233,369	25,748	5,149	.011	20.00
1916	do	492,723	11,523	2,304	.023	20.00
1917	do	408,163	10,029	2,005	.024	20.00
1918	do	179,200	2,376	475	.013	20.00
1919	do	1,285	90	18	.070	20.00

[1] From July 1 to Oct. 3, 1913.
[2] From Oct. 4, 1913 to June 30, 1914.
[3] No imports from 1917 to 1919, inclusive.

PRICES.

The price of barium chemicals increased more during the war than barytes, the raw material. This was undoubtedly due to the fact that this country did not possess a barium chemical industry and therefore the normal demand could not be met with the sudden cessation of imports from Germany. The price of barium chemicals increased rapidly to a high level in the latter part of 1916, which was three and four times the prewar prices. As the production of domestic manufacturers approached the demand, the prices declined somewhat (with the exception of barium chlorate). The prices existing during 1918 and 1919 were about twice the normal prewar prices. Prices of barium carbonate have not been quoted prior to 1919. During 1919 and the first half of 1920 the price was between $65 and $75 per ton. Table 26 shows the price by quarters of the various barium chemicals, as quoted in the Oil, Paint and Drug Reporter.

TABLE 22.—*Price of barium chemicals in the United States, spot, New York market.*

[From Oil, Paint and Drug Reporter.]

	Pulp blanc fixe, per ton.	Dry blanc fixe, per ton.	Barium salts.			
			Chlorate, per pound.	Nitrate, per pound.	Chloride, per ton.	Dioxide, per pound.
1912.			*Cents.*	*Cents.*		*Cents.*
January	$40.00–$43.00	$57.50–$80.00	15–17	5½– 6¼	$31.50–$32.50	.....
April	40.00– 43.00	57.50– 80.00	15–17	5½– 6¼	28.00– 30.00	.....
July	40.00– 43.00	57.50– 80.00	15–17	5½– 6¼	28.00– 30.00	.....
October	40.00– 43.00	57.50– 80.00	15–17	5.1– 6	27.00– 28.00	.....
1913.						
January	40.00– 43.00	57.50– 80.00	15–17	5¾– 6	32.00– 32.50	.....
April	40.00– 43.00	57.50– 80.00	15–17	5¾– 6	33.00 33.50	.....
July	40.00– 43.00	57.50– 80.00	15–17	5¾– 6	31.50– 32.50	.....
October	40.00– 43.00	57.50– 80.00	13–13½	5¾– 6	32.00– 32.50	.....
1914.						
January	40.00– 43.00	57.50– 80.00	13–13½	5¾– 6	32.50– 33.00	.....
April	40.00– 43.00	57.50– 80.00	13–13½	5¾– 6	32.00– 32.50	.....
July	40.00 43.00	77.50– 80.00	13–13¼	5¾– 6	32.00– 32.50	.....
October	40.00– 43.00	77.50– 80.00	16–16½	14 –16	120.00–130.00	.....
1915.						
January	40.00 43.00	77.50– 80.00	16–16½	12 –14	50.00– 60.00	.....
April	40.00– 43.00	77.50– 80.00	16–16½	12 –14	60.00	.....
July	45.00	60.00– 65.00	16–16½	12 –14	70.00– 80.00	22
October	45.00	60.00– 65.00	16–16½	15 –16	95.00–100.00	22
1916.						
January	45.00	80.00	16–16½	15 –16	110.00	22
April	70 00	80.00	50–60	15 –16	..... 140.00	22
July	120.00	120.00–140.00	50–60	15 –16	110.00–120.00	38
October	120.00	90.00	50–60	15 –16	100.00–110.00	38
1917.						
January	80.00– 85.00	110.00	50–60	15 –16	97.50–102.50	38
April	35.00– 40.00	80.00– 85.00	50–60	13 –14	92.50–100.00	38
July	35.00– 40.00	80.00– 85.00	50–60	12 –13	90.00– 95.00	38
October	35.00– 40.00	80.00– 85.00	50–60	12 –13	80.00– 90.00	38

TABLE 22.—*Price of barium chemicals in the United States, spot, New York market*—Continued.

	Pulp blanc fixe, per ton.	Dry blanc fixe, per ton.	Barium salts.			
			Chlorate, per pound.	Nitrate, per pound.	Chloride, per ton.	Dioxide, per pound.
1918.			*Cents.*	*Cents.*		*Cents.*
January	$35.00–40.00	$75.00–80.00	50–60	11 –14	$65.00–90.00	20–25
April	35.00–60.00	95.00–105.00	Nominal.	12 –14	65.00–85.00	Nominal.
July	35.00–60.00	110.00–120.00	50–60	12 –14	[1]65.00–70.00	25 –30
October	35.00–60.00	110.00–120.00	50–60	12 –14	[1]65.00–70.00	25 –30
1919.						
January	35.00–60.00	110.00–120.00	50–60	11½–12	[2]85.00–87.00	25 –27
April	35.00–50.00	70.00–90.00	50–60	10 –11	82.00–85.00	25 –27
July	35.00–50.00	70.00–90.00	50–60	10 –11	70.00–80.00	25 –27
October	35.00–50.00	70.00–90.00	50–60	10 –11	80.00–85.00	25 –27
1920.						
January	35.00–50.00	80.00–100.00	59–60	10 –11	90.00–95.00	21½–22
April	40.00–50.00	100.00	50–60	17 –18	150.00–175.00	23 ..
July	40.00–50.00	120.00	50–60	17 –18	175.00–180.00	22½–25

[1] 80 per cent grade. [2] Listed during 1919–20 as barium chloride, white crystals.

TARIFF HISTORY.

Prior to the tariff act of 1913 the only barium chemical mentioned by name was blanc fixe or artificial sulphate of barium, which was first mentioned in the act of 1890 as dutiable at three-fourths cent per pound. The other barium chemicals were dutiable prior to the passage of the act of 1913 as chemical compounds and salts n. s. p. f. The act of 1913 mentions three barium salts by name in addition to mentioning blanc fixe, and alloys of metallic barium. The tariff classification of the finished barium products since the passage of the act of 1883 is as follows:

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1883	92	* * * and all chemical compounds and salts, * * * not specially enumerated or provided for in this act.	25 per cent ad valorem.
1890	51	Blanc-fixe, * * * or artificial sulphate of barytes	¾ cent per pound.
	76	* * * and all chemical compounds and salts, not specially provided for in this act.	25 per cent ad valorem.
1894	39	Blanc-fixe, or artificial sulphate of barytes	25 per cent ad valorem.
	60	* * * and all chemical compounds and salts, not specially provided for in this act.	25 per cent ad valorem.
1897	46	Blanc-fixe, or artificial sulphate of barytes * * *	½ cent per pound.
	3	* * * and all chemical compounds and salts not specially provided for in this act.	25 per cent ad valorem.
1909	3	* * * chemical compounds, mixtures and salts * * * not specially provided for in this section.	25 per cent ad valorem, or 55 cents per lb. if more.
	44	Blanc-fixe, or artificial sulphate of barytes * * *	½ cent per pound.
1913	5	* * * and all chemical * * * compounds * * *, mixtures and salts * * * .	15 per cent ad valorem.
	10	Barium,	
		Chloride of	¼ cent per pound.
		Dioxide of	1½ cents per pound.
		Carbonate of, precipitated	15 per cent ad valorem.
	51	* * * blanc-fixe, or artificial sulphate of barytes * * * .	20 per cent ad valorem.
	143	* * * barium, * * * and alloys of which said metals are the component material of chief value.	25 per cent ad valorem.

PART IV

THE LITHOPONE INDUSTRY

PART IV.

THE LITHOPONE INDUSTRY.

DESCRIPTION AND USES.

Lithopone (incorrectly spelled lithophone) is a white pigment which consists of a mixture of approximately 70 per cent barium sulphate and 30 per cent of zinc calculated as zinc sulphide. The zinc is present in lithopone as 26 to 28 per cent of zinc sulphide and 1 to 3 per cent of zinc oxide, according to conditions of manufacture. The lithopone produced in this country by all manufacturers is a standard product of approximately the composition given above, which is about in proportion to the chemical equivalents of barium sulphate and zinc sulphide. In Europe lithopone is commonly sold in grades containing more or less zinc sulphide than the standard of 30 per cent. For example, the following grades of lithopone are sold on the German market: Gelbsiegel (yellow seal), 11 to 18 per cent zinc sulphide; Blausiegel (blue seal), 22 to 30 per cent zinc sulphide; Grünsiegel (green seal), 32 to 42 per cent zinc sulphide.

Lithopone is known commercially under various brand names in addition to the general name of lithopone. The trade names used by various manufacturers, with the exception of the Sherwin-Williams Co., of Cleveland, Ohio, which firm markets their product simply as lithopone, are as follows:

Beckton White, E. I. du Pont de Nemours & Co., Wilmington, Del.
Ponolith, Krebs Pigment & Chemical Corporation, Newport, Del.
Marbon White, Mineral Refining & Chemical Corporation, St. Louis, Mo.
Zincolith, Chemical Pigments Corporation, Philadelphia, Pa.
Sterling White, Midland Chemical Co., Chicago, Ill.
B–J White, Butterworth-Judson Corporation, New York.
Grasselli White, Grasselli Chemical Co., Cleveland, Ohio.
Green Label and Standard, New Jersey Zinc Co., New York.
Colzo Lithopone, Collinsville Zinc Corporation, St. Louis, Mo.

Lithopone is used extensively as a white pigment in flat and enamel wall paints for interior use. The chief competitors of lithopone as a pigment are white lead, zinc oxide, and leaded zinc oxide. It is also used in large quantities as an inert filler in rubber goods, paper, linoleum, oilcloth, and in window-shade cloth. As a rule lithopone is not extensively used in outside paints because of the property of darkening when exposed to sunlight. In recent years there have been placed on the market brands of lithopone which are said to withstand exposure to sunlight.

DOMESTIC PRODUCTION.

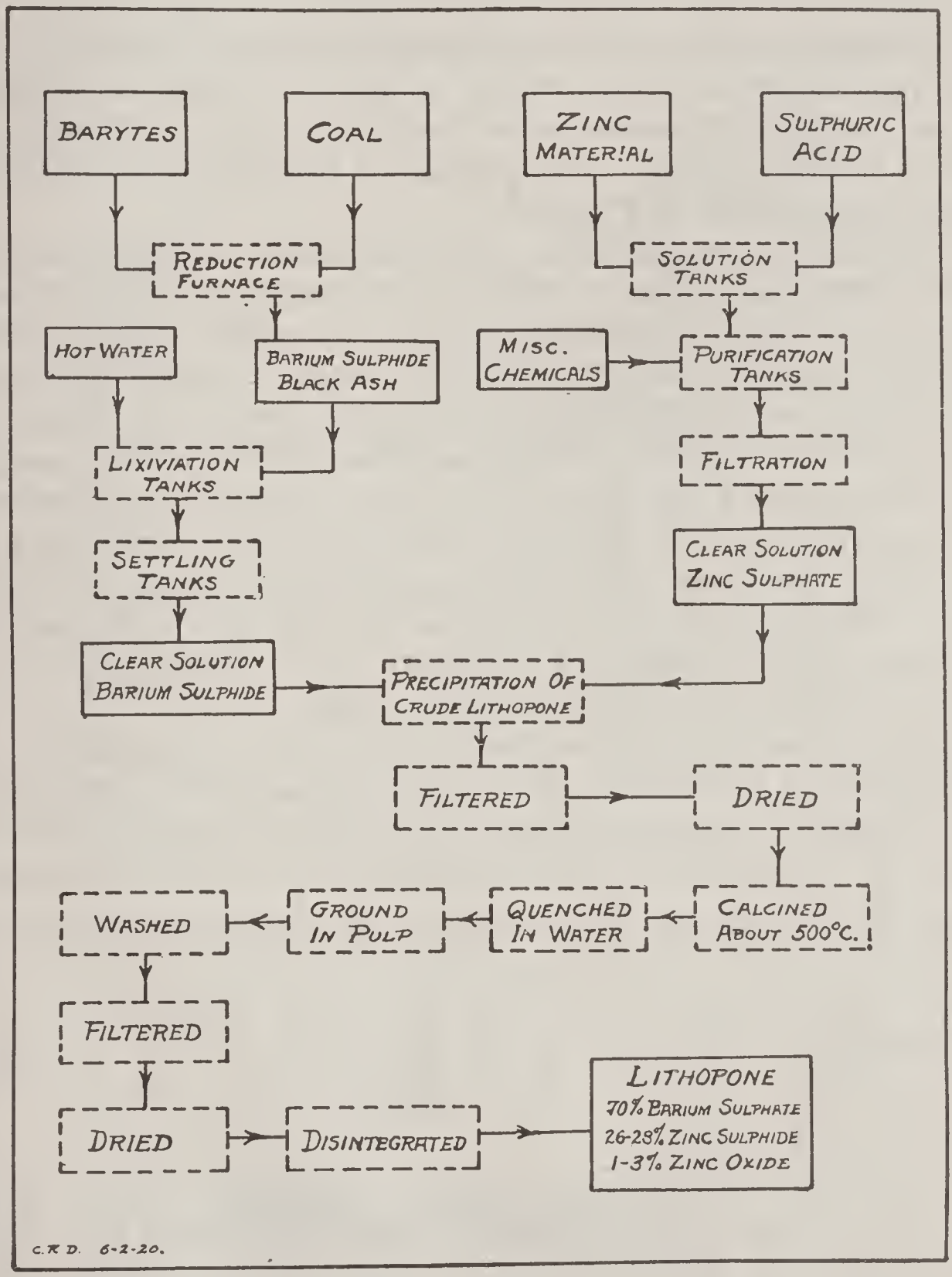
Raw materials.—The basic raw materials necessary for the manufacture of lithopone are crude barytes, coal or coke, zinc, and sulphuric acid. Other chemicals are required in the process of manufacture, but in minor quantities. Large quantities of clear, soft water are required in making up the solutions of materials and in the washing of the lithopone to remove soluble impurities. Of these materials, this report is especially concerned with crude barytes. The other basic raw materials are available from domestic sources, and, with the exception of zinc, present no special tariff problem.

The barytes requirements of lithopone manufacturers prior to the war were supplied wholly by imports, chiefly from Germany. The entire lithopone industry was then located along the Atlantic coast, at or within a short distance of tidewater. Under these conditions crude barytes could be imported at a cost of about $5.20 per short ton, delivered at plant, which was less than the price at which domestic barytes could be purchased. The stoppage of imports of crude barytes from Germany as a result of war conditions forced the lithopone manufacturers to seek a domestic supply. This condition and the establishment of a barium chemical industry was responsible for the domestic development of crude barytes production in the southern district, as previously described. (See p. 21.) It is reasonably certain, with restoration of normal competitive conditions and under existing tariff duties (15 per cent ad valorem) on crude barytes, that lithopone manufacturers located along the Atlantic coast will return to imports as the source of their barytes requirements. Regardless of a duty, the lithopone manufacturers located in the Middle West will use chiefly crude barytes from the Missouri district. The relation of the cost of crude barytes to the total cost of manufacturing lithopone is shown on page 87. From this it is possible to calculate the effect of an increase or decrease in the cost of crude barytes on the cost of lithopone, other factors remaining fixed.

Process of manufacture.—The manufacture of lithopone requires the preliminary production of a solution of barium sulphide and a solution of zinc sulphate. The preparation of barium sulphide by roasting barytes with coal has already been described. (See p. 44.) The zinc sulphate solution is prepared by dissolving some form of zinc (zinc ash, scrap, skimmings, spelter, or roasted ore) in dilute sulphuric acid. Since the zinc materials used contain, as a rule, other metals as impurities (chiefly iron, copper, or cadmium), which would form colored products on treatment with barium sulphide, it is necessary to purify thoroughly the zinc sulphate solution. Various chemicals are used at this point for purification of the zinc

FIGURE 4.—DIAGRAM OF THE MANUFACTURE OF LITHOPONE

Solid lines——Raw, intermediate, or finished products
Broken lines- - - -Apparatus, or steps in process



sulphate solution, which is one of the most important steps in the manufacture and requires careful chemical control.

Crude lithopone is now precipitated from the purified zinc sulphate solution as a white insoluble substance by adding a hot solution of barium sulphide. The crude lithopone is filtered from the solution, then dried, and calcined in a muffle furnace at about 500° C., which may or may not utilize waste heat from the roasting of the barytes with coal. The hot product from the furnace is thrown into water ("quenching"), ground in pulp, washed several times with water to remove soluble impurities, filtered, and dried. The dry lithopone is run through a disintegrator, which breaks it up into a fine powder, and it is then packed in bags or barrels for shipment. In some cases the lithopone is air floated to insure a uniformly fine product before packing. The process of manufacturing lithopone is shown graphically in Figure 4.

Production and consumption.—The production of lithopone in the United States has shown a rapid growth during the last 10 years. From 1910 to 1919 the production increased nearly sixfold, or from 25,330,000 pounds to about 145,000,000 pounds. During this period the domestic output of lithopone has supplied from 84 to 100 per cent of the total consumption. There has been relatively little competition from imported lithopone. The growth of the lithopone industry can be attributed to the increased utilization of this commodity and the natural growth of the consuming industries during the last 10 years. Although exports of lithopone are not shown separately in Commerce and Navigation, it is known that a fairly large export trade has developed in lithopone during 1920.

Table 23 shows the figures for the production, importation, and consumption of lithopone in this country from 1910 to 1919, inclusive. Figure 5 shows graphically the relation of imports and production of lithopone to the total consumption in the United States.

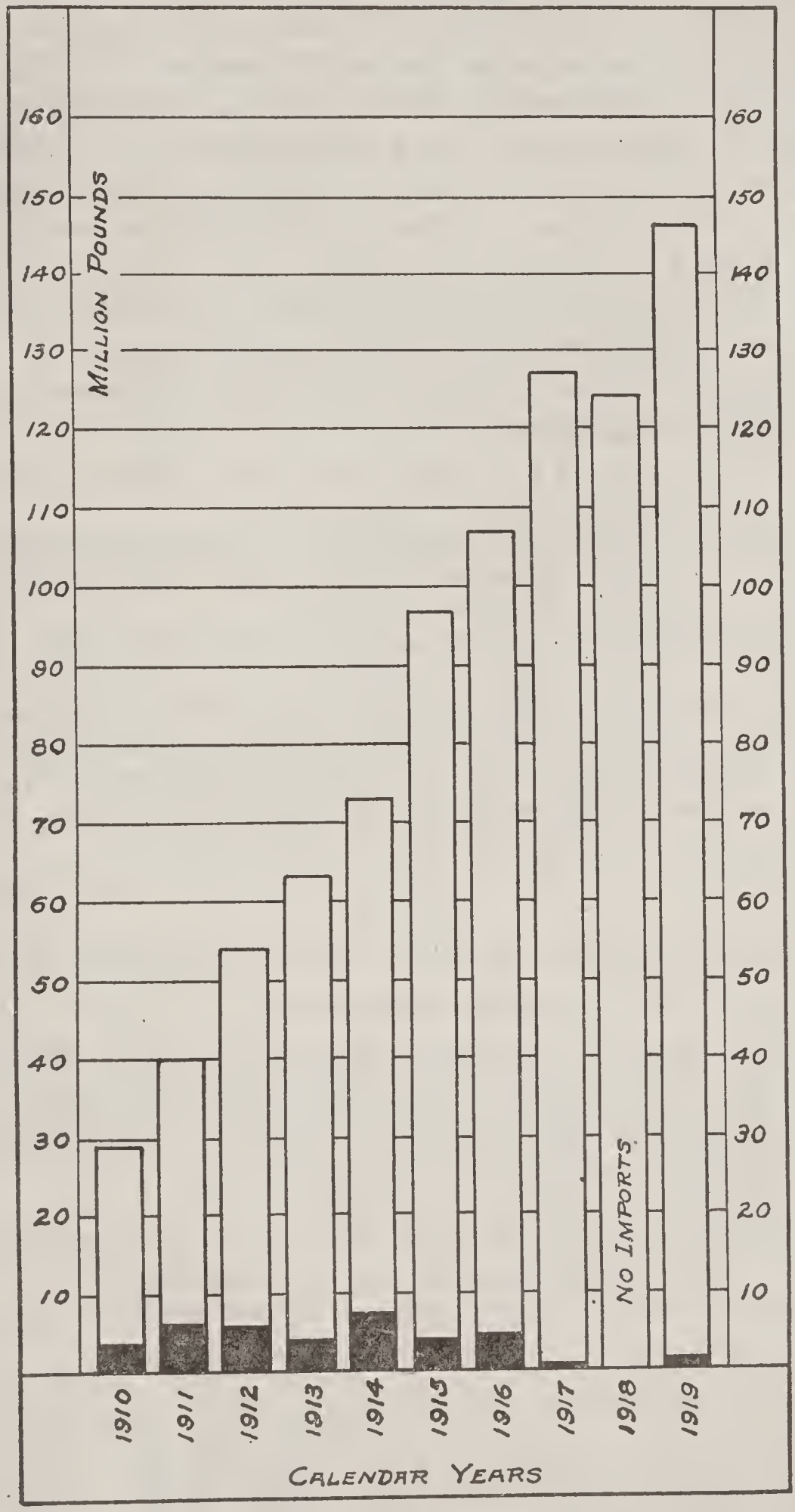
TABLE 23.—*Production and consumption of lithopone in the United States.*

Calendar year.	Production.[1]			Imports.[2]		Consumption.
	Quantity.	Value.	Per cent of consumption (quantity).	Quantity.	Value.	
	Pounds.			*Pounds.*		*Pounds.*
1910	25,330,000	$916,512	87.1	3,726,135	$99,954	29,056,135
1911	33,732,000	1,243,108	84.1	6,355,312	166,199	40,087,312
1912	48,440,000	1,702,119	89.1	5,904,475	153,303	54,344,475
1913	59,370,000	2,170,445	93.6	4,054,423	122,063	63,424,423
1914	65,638,000	2,490,530	89.7	7,544,148	259,955	73,182,148
1915	92,988,000	3,760,472	95.8	4,087,826	137,816	97,075,826
1916	102,582,000	5,798,927	95.6	4,681,560	405,730	107,263,560
1917	127,426,000	7,391,531	99.6	448,000	29,199	127,874,000
1918	124,806,000	7,923,209	100.0	.....	.....	124,806,000
1919	145,000,000	.....	99.0	1,477,296	122,708	146,477,296

[1] 1910 to 1918, inclusive, from Mineral Resources, U. S. Geological Survey. 1919 from reports submitted to the Tariff Commission by individual manufacturers.

[2] From 1910 to Oct. 3, 1913, listed as "white sulphide of zinc."

FIGURE 5 .— CONSUMPTION OF LITHOPONE IN THE UNITED STATES, 1910-1919



C.R.D. 4-27-20.

Geographical distribution.—The domestic lithopone industry, prior to the war, was confined to the Atlantic coast district. Most of the plants were located at tidewater and were thus favorably situated as regards the supply of the raw material, barytes, imported from Germany. According to the Geological Survey there were in 1914 three manufacturers in New Jersey, two in Pennsylvania, and one in Delaware. The Geological Survey reported production of lithopone during 1915 at Chicago by the Midland Chemical Co. This marked the beginning of the lithopone industry in the Middle West and the utilization of local barytes in the manufacture of this paint pigment. There has since been considerable development of the lithopone industry in the Middle West. At the present time there are two manufacturers located in the Chicago district and two in the St. Louis territory. On the basis of the 1919 production about 80 per cent of the lithopone is produced in the Atlantic coast district.

The manufacturers of lithopone, their office addresses, and location of plants are as follows:

E. I. du Pont de Nemours & Co., Wilmington, Del. (Plants at Philadelphia, Pa., Camden and Newark, N. J.)

Krebs Pigment & Chemical Co., Newport, Del. (Plant same address.)

Chemical Pigments Corporation, 617 Stock Exchange Building, Philadelphia, Pa. (Plant at St. Helena, Baltimore, Md.)[1]

Midland Chemical Co., 208 South La Salle Street, Chicago, Ill. (Plant at Argo, Ill.)

New Jersey Zinc Co., 160 Front Street, New York. (Plant at Palmerton, Pa.)

Grasselli Chemical Co., Cleveland, Ohio. (Plant at Grasselli, N. J.)

Sherwin-Williams Co., Cleveland, Ohio. (Plant at Kensington, Ill.)

Butterworth-Judson Corporation, 61 Broadway, New York. (Plant at Newark, N. J.)

Mineral Refining & Chemical Corporation, St. Louis, Mo. (Plant at St. Louis, Mo.)

Collinsville Zinc Corporation, St. Louis, Mo. (Plant at Collinsville, Ill.)

FOREIGN PRODUCTION.

Little information is available as to the size of the lithopone industry in foreign countries. It is known that the principal producers are Germany and Belgium. Table 24 shows Germany's exports and imports of lithopone prior to the war.

TABLE 24.—*Germany's exports and imports of lithopone, 1909–1913.*

[From Vierteljahrshefte zur Statistik des Deutschen Reichs.]

Year.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*	
1909	8,337	$450,436	2,736	$141,967
1910	11,639	503,078	3,684	159,118
1911	15,148	730,559	3,003	129,819
1912	16,825	793,206	3,676	174,839
1913	19,326	950,180	3,405	176,506

[1] Purchased in June, 1920, by the Glidden Co., Cleveland, Ohio.

IMPORTS INTO THE UNITED STATES.

From 1911 to 1916, inclusive, the imports of lithopone were fairly constant at 5,000,000 to 6,000,000 pounds annually with the exception of 1914 when the imports were a little over 8,000,000 pounds. The average dutiable value of lithopone during this period was from 2.5 to 3.1 cents a pound except in 1916 when the price increased to 8.1 cents a pound. In 1917 the imports decreased sharply and during 1918 and 1919 remained between 230,000 and 450,000 pounds a year. Imports of lithopone have supplied only a small portion of the domestic consumption of lithopone. Table 25 shows the imports for consumption of lithopone from 1910 to 1919, inclusive.

TABLE 25.—*Imports of lithopone for consumption in the United States 1910–1919.*[1]

Fiscal year.	Rate of duty.	Quantity.	Value.	Duty collected.	Value per unit of quantity.	Actual and computed ad valorem rate.
		Pounds.				*Per cent.*
1910	1¼ cents per pound	2,307,699	$68,925	$28,846	$0.029	41.85
1911	do	5,409,520	145,201	67,619	.027	46.57
1912	do	6,325,072	157,921	79,063	.025	50.07
1913	do	5,163,642	144,812	64,545	.028	44.57
1914 [2]	do	847,563	25,777	10,594	.030	41.10
1914 [3]	15 per cent	7,245,151	218,133	32,719	.030	15.00
1915	do	6,185,245	195,828	29,374	.031	15.00
1916	do	5,122,083	414,573	62,185	.081	15.00
1917	do	231,869	20,591	3,088	.089	15.00
1918	do	448,000	29,199	4,379	.065	15.00
1919	do	233,338	17,678	2,652	.076	15.00

[1] From 1910 to Oct. 3, 1913, listed as "white sulphide of zinc."
[2] July 1 to Oct. 3, 1913, under act of 1909.
[3] Oct. 4, 1913, to June 30, 1914, under act of 1913.

PRICES.

Domestic.—The price of lithopone from 1912 to 1915 was constant at about 3¾ cents a pound. The price increased to a maximum of 14½ cents a pound in the second and third quarters of 1916. During 1917, 1918, and 1919 the price ranged from 6 to 8 cents a pound, an average of about double the prewar price. The price on July 3, 1920, was 7¾ cents a pound in bags and 8–8¼ cents a pound in barrels, car lots. Table 26 shows the general trend of the price of lithopone as quoted by the Oil, Paint and Drug Reporter.

TABLE 26.—*Prices of lithopone, spot quotation, New York market.*

[Cents per pound.]

First of month.	1912	1913	1914	1915	1916	1917	1918	1919
January	3½–4	3¾–4½	3¾–4½	3¾–4½	6¾–7	6¼–6½	6½–7	7¾–8¼
April	3¾–4	3¾–4½	3¾–4½	4¼–4¾	14½–15½	6¼–6½	7 –8½	[1] 6½
July	3¾–4	3¾–4½	3¾–4½	6	14½–15½	6¼–6½	7½–8½	6½
October	3¾–4½	3¾–4½	3¾–4½	5¾–6¼	8½–10	6 –6½	8 –8½	7

[1] Listed from here on as lithopone, in barrels, car lots.

Foreign.—The following prices fixed by the Association of German Lithopone Manufacturers for export countries were received by the Commission from a reliable source. The prices apply for the last half of 1919.

TABLE 27.—*Prices of 30 per cent lithopone (per 100 kilos) fixed by German manufacturers for export.*[1]

France, Belgium, Luxemburg, and the Levante	francs	108
Switzerland and Italy	Swiss francs	75
Spain and Portugal	pesetas	70
Holland	florins	37
Scandinavia	kroner	62
America	dollars	13
England, South America, Japan, and other oversea countries not otherwise specified	pounds sterling	[2] 33

The price to the United States of $13 per 100 kilograms is equivalent to 5.72 cents a pound f. o. b. Rotterdam with the discount deducted. The price prevailing in the United States during the last half of 1919 was 6½ to 7 cents a pound.

TARIFF HISTORY.

The term "lithopone" did not appear in the tariff law until the act of 1913, when, in paragraph 61, "lithopone and white sulphide of zinc" were provided for with a duty of 15 per cent ad valorem. Under the act of 1890 lithopone was dutiable as "white paint containing zinc, but not containing lead; dry" at 1¼ cents per pound (Gabriel *v.* United States, 65 Fed., 422; G. A. 1319, T. D. 12670), and under the act of 1897 as "sulfid of zinc white, or white sulphide of zinc," at 1¼ cents a pound (Gabriel *v.* United States, 123 Fed., 296). This duty during the fiscal years 1910 to 1913, inclusive, was equivalent to from 42 to 50 per cent ad valorem.

[1] All these prices are subject to 3 per cent discount or rebate for 25 ton orders and upward and are packed in free casks of 250 kilos net with a negligible extra for smaller packages. Delivered Rotterdam or frontier stations.

[2] Per English ton.

PART V

COSTS OF PRODUCTION IN THE BARYTES, BARIUM CHEMICAL, AND LITHOPONE INDUSTRIES, 1919

PART V.

COSTS OF PRODUCTION IN THE BARYTES, BARIUM CHEMICAL, AND LITHOPONE INDUSTRIES, 1919.

Summary of Costs.

Representatives of the Tariff Commission held conferences in New York, Washington, and St. Louis with producers and manufacturers, who agreed to submit their costs of production to the Commission on their own cost forms. These cost reports, after tabulation and study, were verified by comparison with the books of the companies by members of the Commission's staff.

The averages of costs as shown in the tables presented are in all cases weighted averages, based on the actual production of the companies reporting. In no case has a simple average been used in presenting costs. For example, the average cost of lithopone for 1919 has been obtained by dividing the sum of the total cost of all companies by the aggregate production of all companies. This method obviously gives more weight in the average to the costs of a company with a large production than to the costs of a company with a small production. It is believed that the weighted average costs, as given, are representative of conditions in the industries as a whole.

The cost of mining crude barytes in western mines increased from $5.30 per short ton in 1916 to $7.74 in 1919, while the increase in southern mines was from $3.89 to $7.39 per short ton. This corresponds to an increase of 90 per cent for southern mines and 46 per cent for western mines. The cost of manufacturing ground barytes was $11.21 per short ton in 1914; $12.69 in 1916; and $19.25 in 1919, an increase of about 70 per cent from 1914 to 1919. The cost of producing barium chemicals during 1919 was $0.0294 per pound for blanc fixe; $0.0316 per pound for barium carbonate; $0.0539 per pound for barium chloride, and $0.197 per pound for barium peroxide. The average cost of manufacturing lithopone during 1919, as reported by 11 plants, was $0.0602 per pound. Of this total cost 43 per cent was due to material; 18 per cent to labor; 34 per cent to overhead; and 5 per cent to sales expense. The apparent profit of the industry was $0.0065 per pound of lithopone produced. The rela-

tion of crude barytes to the lithopone industry is shown by the fact that about 14 per cent of the total factory cost of lithopone was due to barytes. Zinc is the most expensive material entering into lithopone and amounted to about 22 per cent of the total factory cost. The average factory cost was $0.0571 per pound of lithopone.

Cost of Mining Barytes, 1916 and 1919.

INTRODUCTORY.

The costs of mining barytes during 1916 and 1919, as presented in the following pages, are separated for western and southern mines because of the different methods of mining used. (See p. 24.) In western mines the methods of keeping costs are as a rule inadequate, except in the case of the larger firms. The information submitted by smaller operators has been accepted, although in some cases accurate records were not available for purposes of complete verification. In such instances, however, the costs submitted agreed closely with those of larger operators, whose costs were checked to their books, and therefore they have been included in the following tables. The cost records of southern mines were found to be in better condition than those of western mines. A large part of the mining in the southern district is done by large consumers of crude barytes, who keep accurate records. There was, however, very little uniformity in the detail of costs submitted by the various companies.

The outstanding difference in costs as reported by companies in both mining districts was in the charge for amortization of investment due to depletion of ore body and in royalties paid owners of the property for mining privileges. In many cases no charge was reported. As it would be manifestly unfair to include a charge for amortization in one case and not in another, a total cost based on a uniform charge for amortization and royalties for all companies has been shown in the tables of costs of mining barytes. It has seemed feasible to use uniformly the weighted average of the charges reported. In a few cases where charges reported as amortization appeared excessive on account of being based on a short period, they were not used in arriving at the uniform charge.

The costs as given for barytes in all cases are the costs on board cars for shipment. This seemed a more desirable basis for comparison between districts, because this cost plus freight rates gives the cost of crude barytes delivered at any point in the United States. The costs, therefore, as given include hauling, weighing, and loading in the case of the western mines and switching or hauling charges in the case of the southern mines.

COMPARISON OF COSTS IN WESTERN AND SOUTHERN MINES.

TABLE 28.—*Comparison of total cost of mining barytes in western and southern mines during 1916 and 1919.*

[Per short ton.]

1	2	3	4	5
Year.	Cost in western mines.		Cost in southern mines.	
	As reported.	On uniform amortization and royalty basis.	As reported.	On uniform amortization and royalty basis.
1916	$5.30	$5.96	$3.89	$3.89
1919	7.74	7.97	7.39	6.31

Table 28, which compares the costs in the western and southern mines, shows that the cost of production during 1916 and 1919 was lower in the southern than in the western mines. In 1916 the difference in the costs "as reported" (columns 2 and 4) was $1.41 per short ton. On a basis of uniform amortization and royalties (columns 3 and 5) the difference was even greater and amounted to $2.07 per short ton. This is due to the fact that in only a few cases did western mines report a charge for amortization or royalties. In 1919 the difference in costs between the two districts was considerably less. The costs "as reported" in 1919 showed a difference of $0.35 per short ton, and on the basis of "uniform amortization and royalties" a difference of $1.66 per short ton in favor of the southern mines.

Table 28 also shows that the increase in the cost of producing barytes from 1916 to 1919 "as reported" was much greater in case of the southern mines than the western mines. The total average cost in southern mines increased from $3.89 per short ton in 1916 to $7.39 in 1919, or an increase of 90 per cent. The average cost in the western mines increased from $5.30 per ton in 1916 to $7.74 per ton in 1919, or an increase of about 46 per cent. On a basis of "uniform amortization and royalties" the costs in western mines increased about 33 per cent and in southern mines by about 62 per cent during this period.

A study of costs in western and southern mines reveals a considerable difference in labor charge per ton of barytes. This is to be expected from the methods used in the two districts. The western deposits are worked by pick and shovel and require more labor, while the southern deposits are mined by steam shovels. In 1916 the cost of labor in western mines was $2.37 per ton as compared with $1.62 per ton for southern mines, or a difference of $0.75 per ton.

In 1919 the charge for labor in western mines was $4.38 as against $2.82 in southern mines, or a difference of $1.56 per ton. The labor per ton of ore in western mines increased about 85 per cent from 1916 to 1919, while in southern mines there was an increase of 74 per cent. The difference in labor per ton of ore mined in favor of southern mines is in part offset by larger overhead charges, due to necessary investment in mining equipment.

COSTS IN WESTERN MINES.

The methods of mining and conditions in the western fields are unique. Practically all of the mining is done by individuals on a tonnage basis. Each miner is paid a certain rate per ton of ore mined. Other charges are on the same basis. The prices paid for ore delivered at the loading platform at the shipping point are fairly uniform. The price paid for hauling to the shipping point varies with the distance. The miner receives the difference. In other words, the net price received per ton of ore by miners located close to the railroad is greater than that received by miners some distance from the railroad. This condition results in most of the mining being done close to the railroad. A large part of the mining is on property owned by consumers of crude barytes. These companies permit miners to work the property, and they usually furnish the miners with housing free of charge as an inducement to keep them on the property.

TABLE 29.—*Cost of mining barytes in western mines during 1916, by companies.*

[Per short ton.]

1	2	3	4	5	6	7	8
	Total cost.		Detail of total cost as reported (column 2).				
Company No.	As reported.	On uniform amortization and royalty basis.	Labor in mining.	Transportation to shipping point.	Weighing and loading.	Amortization and royalties.	Other expenses.
1	$6.17	$6.25	$2.36	$1.98	$0.35	$0.97	$0.51
2	6.30	6.10	3.00	1.50	.25	1.25	.30
3	6.75	7.80	1.50	4.00	.25	.....	1.00
4	3.80	4.85	2.70	.80	.19	.....	.11
Weighted average cost	5.30	5.96	2.37	1.87	.25	{ .39 [1] 1.05 }	.42

[1] Uniform charge for amortization and royalties used in arriving at total cost in column 3.

Table 29 shows the cost of mining barytes by western mines during 1916 by companies. The total weighted average cost "as reported" of $5.30 per ton is made up of the following charges: $2.37

for labor in mining, or 45 per cent; $1.87 for transportation to shipping point, or 35 per cent, and $0.25 for weighing and loading, or 4.7 per cent. Amortization and royalties were reported by only two firms and are the only charges for these items included in the total average cost of $5.30. By applying a uniform charge for amortization and royalties ($1.05), which was the weighted average of the two charges reported, the average costs for each firm, as shown in column 3, were obtained. This method increases the average cost as reported by $0.69 per ton, or 13 per cent.

TABLE 30.—*Cost of mining barytes in western mines during 1919, by companies.*

[Per short ton.]

1	2	3	4	5	6	7	8
Company No.	Total cost.		Detail of total cost as reported (column 2).				
	As reported.	On uniform amortization and royalty basis.	Labor in mining.	Transportation to shipping point.	Weighing and loading.	Amortization and royalties.	Other expenses.
1	$7.66	$7.47	$4.56	$2.01	$0.13	$0.96	.....
2	9.45	10.22	2.50	5.35	.30	.....	$1.30
3	7.00	7.77	5.88	1.00	.12	.....	.....
4	8.50	8.77	2.00	6.00	.....	.50	.....
5	8.03	7.09	3.20	2.48	.17	1.71	.47
6	8.82	9.59	5.60	1.40	.80	.....	1.02
7	7.80	8.57	6.00	1.40	.30	.....	.10
8	8.00	7.27	4.50	1.50	.25	1.50	.25
9	8.10	8.87	5.00	1.60	.30	.....	1.20
10	7.59	7.76	3.77	2.01	.17	.60	1.04
Weighted average cost	7.74	7.97	4.38	2.01	.20	{ .54 / [1] .77 }	.61

[1] Uniform charge for amortization and royalties used in arriving at total cost, column 3.

Table 30, identical with Table 29, except that the costs given are for the year 1919, shows a total weighted average cost for 1919 "as reported" by 10 companies of $7.74 per short ton. By applying a uniform charge for amortization and royalties the total average cost was increased to $7.97 per short ton, or by about 3 per cent. The total average cost "as reported" is made up of the following charges: Labor in mining of $4.38 per short ton, or 56.5 per cent; transportation to shipping point of $2.01 per short ton, or 26 per cent; weighing and loading of $0.20 per ton, or 2.6 per cent; amortization and royalties of $0.54 per ton, or 7 per cent; and other expenses of $0.61 per ton, or 7.9 per cent. The total cost as shown in column 3 is based on a uniform charge for amortization and royalties, which was $0.77 per short ton, or the weighted average of all firms reporting a charge for amortization and royalties as shown in column 7.

This method increased the cost as reported by all companies, with the exception of three firms.

The charge for "labor in mining," as shown in column 4, is the charge which was reported by the various companies, with the exception of companies 1 and 10. These two firms reported labor in mining and transportation to shipping point combined. The weighted average charge as reported by all other companies for transportation to shipping point has been applied to costs of these two firms, in order to arrive at a figure for labor in mining. As shown by column 4, the labor in mining varied between companies from $2 per ton to $6 per ton. This variance in cost of labor is offset by the charge for transportation as shown in column 5. The transportation charge varied from $1 per ton to $6 per ton. Wherever a high charge for labor is reported a low transportation charge is usually given. The cost delivered at shipping points, or the sum of columns 4 and 5, is fairly uniform, because of existing conditions which have previously been discussed. (See p. 66.) The transportation costs as given are those reported by the various companies, with the exception of companies 1 and 10, as noted above.

Column 6 shows the charge for weighing and loading the crude barytes on board cars, which was reported by all firms but one—company 4. This charge shows a variation from $0.12 per ton to $0.80 per ton. Column 7 shows the amortization and royalties as reported by 5 of the 10 companies. This charge ranged from $0.50 per ton to $1.71 per ton. The weighted average for the five companies reporting was $0.77 per ton, and was used in arriving at the total cost in column 3. The average charge of $0.54 per ton is the total of charges for amortization and royalties divided by the total production of all firms, and was used in arriving at the total cost "as reported" shown in column 2. Column 8 shows other expenses charged to cost of mining barytes. Under this heading are included such overhead items as administration, housing furnished miners, and losses in weight during shipping.

COSTS IN SOUTHERN MINES.

The costs of mining barytes, as shown for southern mines, include companies operating in the Sweetwater, Tenn., and Cartersville, Ga., districts. Only three firms were able to report costs for 1916, because the industry was developed in this district as a result of war conditions, and at this stage of the development little attention was given to cost records. The costs of the companies reporting, however, may be taken as representative for the year 1916. In 1919 the industry in these districts was more fully developed and costs were reported by 12 companies.

TABLE 31.—*Costs of mining barytes in southern mines during 1916, by companies.*

[Per short ton.]

1	2	3	4	5	6
Company No.	Total cost (as reported).	Labor in mining.	Supplies in mining.	Amortization and royalties.	Other expenses.
1	$4.00	$1.25	$0.10	$0.50	$2.15
2	3.71	1.29	.25	1.51	.66
3	4.08	2.29	.....	.25	1.54
Weighted average cost	3.89	1.62	.14	.90	1.23

Table 31 shows the cost of mining barytes by southern mines during 1916. The total weighted average cost "as reported" was $3.89 per short ton, and is made up of $1.62 for labor in mining, or 41.7 per cent; $0.14 for supplies in mining, or 3.6 per cent; $0.90 for amortization and royalties, or 23.1 per cent; and $1.23 for other expenses, or 31.6 per cent. A charge for supplies in mining (column 4) was reported by only two of the three firms, and was $0.10 per ton in one case and $0.25 per ton in the other. Since an amortization and royalty charge was shown by all firms and the charge appeared reasonable, it was not necessary to apply a uniform amortization and royalty charge to the costs.

TABLE 32.—*Costs of mining barytes in southern mines during 1919, by companies.*

[Per short ton.]

1	2	3	4	5	6	7
Company No.	Total cost.		Detail of Total Cost as reported (Column 2).			
	As reported.	On uniform amortization and royalty basis.	Labor in mining.	Supplies in mining.	Amortization and royalties	Other expenses.
1	$6.85	$6.48	$2.50	$0.15	$1.00	$3.20
2	12.25	12.21	5.88	2.67	.67	3.03
3	10.92	11.10	6.05	2.37	.45	2.05
4	10.93	4.92	2.53	.97	6.64	.79
5	5.16	5.06	4.02	.....	.73	.41
6	6.58	6.32	3.34	.50	.89	1.85
7	5.80	5.05	2.14	.03	1.38	2.25
8	5.24	5.87	1.06	.....	.....	4.18
9	8.64	9.27	3.62	.42	.....	4.60
10	9.77	9.54	6.63	.47	.86	1.81
11	7.06	7.44	3.90	.....	.25	2.91
12	6.82	7.45	3.03	1.13	.....	2.66
Weighted average cost	7.39	6.31	2.82	.46	{ 1.71 [1] 10.63 }	2.40

[1] Uniform charge for amortization and royalties used in arriving at the total cost in column 3.

Table 32 shows the cost of mining barytes in southern mines during 1919, as reported by 12 companies. The total weighted average cost, "as reported" (column 2), was $7.39 per short ton, and is made up of the following charges: $2.82 for labor in mining, or 38.2 per cent; $0.46 for supplies in mining, 6.2 per cent; $1.71 for amortization and royalties, or 23.2 per cent; and $2.40 for other expenses, or 32.4 per cent. Column 3 shows the total cost of mining barytes on the basis of a uniform amortization and royalty charge. The total weighted average cost on this basis is $6.31 per short ton, or a decrease of $1.08 per ton, or 14.6 per cent from the total average cost, "as reported." The uniform charge used in arriving at this total cost was $0.63 per ton. This charge was arrived at by taking the weighted average of the amortization and royalty charges shown in column 6, with the exception of certain charges which were omitted. Column 7 shows other expenses charged by the various companies to cost of mining barytes during 1919, which include charges for administration, power, and other overhead expenses.

Cost of Manufacturing Ground Barytes, 1914, 1916, and 1919.

INTRODUCTORY.

The cost of manufacturing ground barytes, as shown, includes companies operating plants both in the southern and western districts. It was impossible to compare costs between the two districts on account of the small number of manufacturers. In compiling the costs on ground barytes the Commission found that the various companies kept detailed cost records. There was very little uniformity, however, in the detail of the costs, as reported.

It should be pointed out that the company numbers used in presenting costs of ground barytes do not necessarily represent the same company for all years. For example, costs given as those of company 1 during 1914, 1916, and 1919 are not directly comparable as those of the same firm.

COMPARISON OF COSTS FOR 1914, 1916, AND 1919.

TABLE 33.—*Comparison of costs of manufacturing ground barytes during 1914, 1916, and 1919.*

[Per short ton.]

1	2	3	4		5		6		7	
Year.	Total cost.	Factory cost.							Selling expenses.	
		Total.	Material.		Labor.		Overhead.			
			Cost.	Per cent of total cost.	Cost.	Per cent of total cost.	Cost.	Per cent of total cost.	Cost.	Per cent of total cost.
1914.....	$11.21	$10.61	$6.13	54.7	$1.30	11.6	$3.18	28.4	$0.60	5.3
1916.....	12.69	11.98	8.08	63.7	1.08	8.5	2.82	22.2	.71	5.6
1919.....	19.25	18.63	10.68	55.5	2.47	12.8	5.48	28.5	.62	3.2

Table 33 compares the total average cost of manufacturing ground barytes during 1914, 1916, and 1919, and the percentage of the total cost due to the various items of cost. Column 2 shows that the total cost increased from $11.21 in 1914 to $19.25 in 1919. The total cost, as given in column 2, is the sum of the total factory cost in column 3 and selling expense in column 7. Column 3 shows that the total

factory cost increased from $10.61 in 1914 to $18.63 in 1919. This increase is in practically the same ratio as the total cost, since the selling expense during the different years was practically uniform at between $0.60 and $0.71 per ton, as shown in column 7. Column 4 shows that the material charge varied from $6.13 in 1914 to $10.68 in 1919. The charge for material is the principal cost item entering into the total cost of ground barytes and amounted to between 55 and 65 per cent of the total factory cost. Column 5 shows the labor charges per ton of ground barytes, which decreased from $1.30 per ton in 1914 to $1.08 in 1916 and then increased to $2.47 per ton in 1919. Labor accounted for 8.5 to 13 per cent of the total cost. Column 6 shows that the overhead expense decreased from $3.18 in 1914 to $2.82 in 1916 and then increased to $5.48 in 1919. Overhead expense was 22 to 29 per cent of the total cost. Selling expense was between 3 and 5.5 per cent of the total cost.

DETAIL OF COSTS OF GROUND BARYTES, BY COMPANIES.

TABLE 34.—*Cost of manufacturing ground barytes, by companies, during 1914.*

[Per short ton.]

1	2	3	4	5	6	7
Company No.	Total cost.	Factory cost.				Selling expenses.
		Total.	Material.	Labor.	Overhead.	
1	$12.09	$11.57	$5.65	$1.88	$4.04	$0.52
2	10.51	9.88	6.43	.74	2.72	.63
3	12.49	11.89	6.16	2.13	3.60	.60
4	11.74	11.14	5.72	2.08	3.34	.60
Weighted average cost	11.21	10.61	6.13	1.30	3.18	.60

Table 34 shows the cost of manufacturing ground barytes by companies during 1914. Column 2 shows that the total weighted average cost as reported by four companies during 1914 was $11.21 per short ton. The total average cost was made up of the following charges: $6.13 per ton for material, or 54.7 per cent; $1.30 per ton for labor, or 11.6 per cent; $3.18 per ton overhead charges, or 28.4 per cent; and $0.60 per ton for selling expenses, or 5.3 per cent.

The total factory cost shown in column 3 is made up of the items material, labor, and overhead. The average factory cost of the four companies reporting was $10.61 per ton. Companies 1 and 2 were the only firms that reported selling expense (column 7). The weighted average of these two firms was taken as the average selling expense and substituted for companies 3 and 4 in arriving at the total cost in column 2 for these two firms.

TABLE 35.—*Cost of manufacturing ground barytes, by companies, during 1916.*

[Per short ton.]

1	2	3	4	5	6	7
Company No.	Total cost.	Factory cost.				Selling expenses.
		Total.	Material.	Labor.	Overhead.	
1	$15.69	$14.99	$9.63	$1.11	$4.25	$0.70
2	11.49	10.77	8.00	.54	2.23	.72
3	12.43	11.72	6.28	2.05	3.39	.71
4	13.24	12.53	7.58	2.07	2.88	.71
Weighted average cost	12.69	11.98	8.08	1.08	2.82	.71

Table 35 shows the cost of manufacturing ground barytes by companies during 1916. Column 2 shows that the average cost of the four companies was $12.69. The average cost is made up of a charge of $8.08 for material, or 63.7 per cent; $1.08 for labor, or 8.5 per cent; $2.82 for overhead, or 22.2 per cent; and $0.71 for selling expenses, or 5.6 per cent. Column 3 shows that the total average factory cost was $11.98. The selling expenses as reported by companies 1 and 2 was $0.70 and $0.72 per ton, respectively. The weighted average of these two charges, or $0.71, was inserted as the selling expenses for companies 3 and 4, and was used in arriving at the total cost shown in column 2 for these two companies.

TABLE 36.—*Cost of manufacturing ground barytes, by companies, during 1919.*

[Per short ton.]

1	2	3	4	5	6	7
Company No.	Total cost.	Factory cost.				Selling expenses.
		Total.	Material.	Labor.	Overhead.	
1	$25.61	$24.73	$12.50	$3.00	$9.23	$0.88
2	19.07	18.10	11.59	1.26	5.25	.97
3	14.51	13.89	7.40	3.26	3.23	.62
4	19.54	19.35	10.74	3.08	5.53	.19
Weighted average cost	19.25	18.63	10.68	2.47	5.48	.62

Table 36 shows the cost of ground barytes during 1919 as reported by four companies. The total weighted average cost (column 2) was $19.25 per ton. This total cost was made up of the following charges: $10.68 per ton for material, or 55.5 per cent; $2.47 for labor, or 12.8 per cent; $5.48 for overhead, or 28.5 per cent, and $0.62 for selling expenses, or 3.2 per cent. The total factory cost, as shown in column 3, averaged $18.63 per ton. During 1919 all companies reported

separately a charge for selling expenses, with the exception of No. 3, which firm included selling under overhead. The weighted average of the three firms separately reporting a charge was inserted for company 3, and subtracted from that company's overhead as reported and from total cost shown in column 2 to obtain the total factory cost. The average selling expense of the three companies reporting was $0.62 per short ton.

TABLE 37.—*Details of overhead charged to ground barytes, 1919.*

[Per short ton.]

1	2	3	4	5
Company No.	Total overhead.	Works expense.	Fixed charges.	Administration.
1	$9.23	$7.45	$0.58	$1.20
2	5.25	2.29	2.54	.42
3	3.23	2.92	.....	.31
4	5.53	5.07	.....	.46
Weighted average	5.48	4.03	.....	.50

The detail in which overhead charges for ground barytes were reported varied greatly. Therefore the total overhead is the only fair basis of comparison between companies. The overhead during 1919 as reported by the four companies manufacturing ground barytes is given in Table 37 in as much detail as was possible. Although not directly comparable by companies, the table shows the detail to which overhead was distributed. The total overhead as shown in column 2 varied between companies from $3.23 to $9.23 per short ton of ground barytes produced.

Column 3 shows the total of the items charged to works expense, which includes such items of cost as operating and miscellaneous supplies, repairs, coal or electric power, packages, and other general plant expense. Works expense is seen to be the largest overhead charge, and averaged $4.03 per short ton, or about 70 per cent of the total overhead. Column 4 shows fixed charges as reported by only two companies. This heading includes insurance, State and local taxes, and depreciation. Only one firm reported a charge for depreciation. Column 5 shows administration expense as reported by all companies. This heading includes salaries for factory superintendence and office expense and salaries. Administration expense averaged $0.50 per short ton, or about 10 per cent of the total overhead.

Costs of Manufacturing Barium Chemicals, 1919.

INTRODUCTORY.

Before discussing the costs of barium chemicals the Commission desires to point out the lack of adequate cost-finding methods found to be prevalent in the barium chemical industry. The Commission does not wish to convey the impression that all companies manufacturing barium chemicals do not keep accurate cost records, but a number of the firms engaged in this industry lack adequate methods of cost accounting, and the data obtained from the records of these companies are at best an approximation of the true cost. This condition may be accounted for by the fact that the industry was developed under stress of war conditions, with emphasis on output rather than on economy of operation and on accurate cost records. Now that the industry is approaching more stabilized conditions, more attention should be given to cost accounting by those firms which now have inadequate methods. The Commission emphasizes the fact that some of the manufacturers of barium chemicals have adequate cost systems, and had this condition uniformly prevailed the cost investigation would have been greatly facilitated. From the information available the Commission is able to present the following costs of barium chemicals, and believes that the costs given may be taken as representative of the industry.

COMPARISON OF COSTS OF BARIUM CHEMICALS.

TABLE 38.—*Cost of manufacturing barium chemicals during 1919.*

[Per pound.]

Name of product.	Manufacturers reporting.	Total cost.	Material.		Labor.		Overhead and selling expense.	
			Cost.	Per cent of total.	Cost.	Per cent of total.	Cost.	Per cent of total.
Barium carbonate	3	$0.0316	$0.0167	52.9	$0.0038	12.0	$0.0111	35.1
Barium peroxide	3	.197	.088	44.7	.046	23.3	.063	32.0
Blanc fixe [1]	3	.0294	.0160	54.4	.0028	9.5	.0106	36.1
Barium chloride	4	.0539	.0218	40.5	.0109	20.2	.0212	39.3

[1] Precipitated barium sulphate.

Table 38 shows the weighted average costs of four barium chemicals—barium carbonate, barium peroxide, barium chloride, and blanc fixe or precipitated barium sulphate. This table also shows the

total cost distributed to the three items—material, labor, and overhead. The Commission is unable to publish costs submitted on other barium chemicals without disclosing the costs of the one or two firms reporting. The barium chemicals for which costs are given are, however, the most important, and include all barium chemicals mentioned by name in the tariff act of 1913. The costs of these may be taken as representing conditions in the industry.

It has been necessary, because of the form in which costs were kept by the companies, to combine overhead and selling expenses. In all cases selling expense is included, with the exception of one firm manufacturing barium chloride. Depreciation on plant and equipment is included in overhead where reported. A charge for depreciation was reported by all manufacturers of barium peroxide; by three of the four manufacturers of barium chloride; and by one manufacturer of barium carbonate. No depreciation was reported by manufacturers of blanc fixe. Other discrepancies in cost items are discussed under the variation in costs by companies.

Table 38 shows that the total average cost for precipitated barium carbonate, as reported by three manufacturers, was $0.0316 per pound. This cost was made up of the following items: Material charge of $0.0167, or 52.9 per cent; labor charge of $0.0038, or 12 per cent; and overhead and selling expenses of $0.0111, or 35.1 per cent. This table shows a total average cost for barium peroxide of $0.197 per pound as reported by three companies. Of this total, $0.088, or 44.7 per cent, was due to material charges; $0.046, or 23.3 per cent to labor charge; and $0.063, or 32 per cent, to overhead and selling expenses. The total average cost of blanc fixe for three firms is shown as $0.0294 per pound. This total cost is made up of $0.0160 material charge, or 54.4 per cent; $0.0028 labor charge, or 9.5 per cent; and $0.0106 overhead and selling expenses, or 36.1 per cent. The total average cost of barium chloride for 1919 as reported by four manufacturers was $0.0539 per pound. This total was made up of material charge of $0.0218, or 40.5 per cent; labor charge of $0.0109, or 20.2 per cent; and overhead and selling expenses of $0.0212, or 39.3 per cent.

The barium chemicals in order of their cheapness of manufacture, as shown in Table 38, are blanc fixe, barium carbonate, barium chloride, and barium peroxide. This order would be expected from a knowledge of the process of manufacture. Blanc fixe and barium carbonate, whose costs vary by only 0.22 cent per pound, are made from comparatively cheap chemicals, are precipitated as insoluble compounds, and require but simple operations, such as filtration and drying before marketing. Barium chloride, although made from a cheap material—calcium chloride—is a soluble compound and requires considerable heat for evaporation of solutions. This

is reflected in a higher overhead charge than for blanc fixe and barium carbonate. Barium peroxide requires a higher degree of manufacture than any of the other barium chemicals. It is made from intermediate barium chemicals—barium carbonate or barium nitrate. Large quantities of heat are required for its manufacture, which is reflected in the largest unit overhead charge. Based on percentage of total cost, however, the overhead for barium peroxide is less than for blanc fixe or barium carbonate.

From a study of Table 38 it is seen that the cost of materials is in inverse ratio to the total cost of production. The percentage of the total cost due to material ranges from 40.5 per cent in the case of barium chloride to 54.4 per cent in the case of blanc fixe. It is also seen that the cost due to labor is in direct ratio to the total cost of the various barium chemicals. The percentage of the total cost due to labor ranges from 9.5 per cent for blanc fixe to 23.3 per cent for barium peroxide. The percentage of the total cost due to overhead and selling expense is more nearly uniform than the other cost charges. This charge ranges from 32 per cent of the total cost for barium peroxide to 39.3 per cent of the total cost for barium chloride.

VARIATIONS IN COSTS OF BARIUM CHEMICALS, BY COMPANIES.

TABLE 39.—*Percentage variation in costs of barium chemicals, by companies, for 1919.*

	Total cost.	Material.	Labor.	Overhead and selling expense.
Barium carbonate:				
Company No. 1	101	170	66	58
Company No. 2	100	100	100	100
Company No. 3	69	108	30	52
Barium peroxide:				
Company No. 1	135	246	49	61
Company No. 2	100	100	100	100
Company No. 3	92	63	174	78
Blanc fixe (precipitated barium sulphate):				
Company No. 1	181	178	178	185
Company No. 2	96	139	91	37
Company No. 3	100	100	100	100
Barium chloride:				
Company No. 1	100	100	100	100
Company No. 2	86	136	54	61
Company No. 3	151	255	73	104
Company No. 4	164	91	189	212

Table 39 shows by percentage the variation in the total cost and in the items of cost of each barium chemical by manufacturers. Because of the few manufacturers of each chemical it was impossible to show the variation in costs by publishing the actual units. In each case the firm with the median total cost has been taken as the unit of 100. The other costs are calculated as a percentage of this unit. As can be seen from Table 39 it is generally true that a manufacturer

who has the lowest total cost is not always low in all departments of cost.

This table shows a variation in the total cost of barium carbonate from 69 to 101, or a difference of nearly 50 per cent of the low cost. This difference may be due to differences in process of manufacture, methods of treating by-products, or to individual plant and process efficiencies. There are two general methods used in the manufacture of barium carbonate. The one is to treat barium sulphide with soda ash, thus obtaining by-product sodium sulphide. The other method is to convert the barium sulphide into barium carbonate by means of carbon dioxide. This method does not give a by-product. The accounting method used in treating sodium sulphide may vary between manufacturers with a resulting reflection in the total cost. Sodium sulphide was uniformly treated as a joint product, and the raw-material charges divided between barium carbonate and sodium sulphide on an arbitrary basis. The basis of distribution of raw material, however, varied between the manufacturers. The method followed by each firm has been used in arriving at the total cost.

The total cost of barium peroxide ranged from a low of 92 to a high of 135, or a difference of nearly 50 per cent of the low cost. The variation in the cost of barium peroxide may be accounted for largely by the difference in process of manufacture. It is produced by two methods, one using barium carbonate as the raw material and the other using barium nitrate. The difference in total cost is reflected chiefly in the material charge which shows a difference between the low and high of about 300 per cent. The company with the highest total cost had the lowest labor, while the firm with the lowest total cost had the highest labor cost.

The total cost of blanc fixe varied from 96 to 181, as shown in Table 39. This is a difference of nearly 100 per cent of the low cost. In arriving at the total cost for blanc fixe in the case of one firm it was necessary for comparison to substitute an average material charge, which was the weighted average of the material charges reported by the other two manufacturers. From a study of the variation of costs of blanc fixe, it is seen that the company with the highest total cost is the highest in all departments of cost. This is the only case where one company is the highest in all cost items. What has been said of the effect of sodium sulphide on the cost of barium carbonate, also applies to costs of blanc fixe. Some of the companies reporting blanc fixe costs obtain sodium sulphide as a by-product, while others produce blanc fixe by a process which does not yield sodium sulphide. These differences are necessarily reflected in total costs.

The total cost of barium chloride reported by four companies ranged from a low of 86 to a high of 164, or a difference of about 90 per cent of the low cost. Three of the firms use similar processes involving the direct production of barium chloride from barytes by reduction with coal in the presence of calcium chloride. The other firm reporting made barium chloride from an intermediate barium chemical. The difference in total cost, however, can not be accounted for wholly by differences in process of manufacture. It is interesting to note that the firm with the highest total cost had the lowest material cost, but had high labor and overhead and selling charges.

Cost of Manufacturing Lithopone, 1919.

INTRODUCTORY.

The Commission's investigation of costs in the lithopone industry was greatly facilitated by the fact that practically all companies kept detailed cost records. The methods of accounting used by the lithopone manufacturers were more detailed and in a more comparable form than those of the barytes and barium chemical industries. This may be accounted for by the fact that the lithopone industry is much larger, has been longer established, and is on a more permanent basis than the other industries. Although costs were shown in detail, there was considerable lack of uniformity in methods of treating individual cost items. The outstanding differences were methods of handling raw material charges, methods of determining selling expenses, and treatment of administrative expenses. These differences are discussed fully in the following pages.

In analyzing the cost statements on lithopone for 1919, and in comparing and presenting the cost data of the industry, the methods used by the majority of the companies in distributing the charges have been followed as closely as possible. Wherever changes have been necessary in order to facilitate comparison, they are explained in the discussion of the individual cost items. Where companies operate more than one plant and have reported separate costs for each, they have been tabulated as if for separate companies. The costs for lithopone as shown represent 11 plants, operated by 9 companies. Two plants did not report costs for the first quarter of the year 1919, and one plant presented costs for the last quarter only. The costs of these plants have been used as representative of the entire year.

COMPARISON OF COSTS OF LITHOPONE BY QUARTERS.

TABLE 40.—*Weighted average cost of lithopone during 1919 by quarters.*

[Per pound.]

1	2	3	4	5	6	7	8	9
Quarterly periods.	Production.	Total cost.	Material cost.	Direct labor cost.	Factory overhead.	Selling expense.	Average sales price.	Apparent average profit.
	Pounds.							
First	24,613,042	$0.0639	$0.0264	$0.0101	$0.0239	$0.0035	$0.0709	$0.0070
Second	28,479,697	.0573	.0254	.0103	.0191	.0025	.0633	.0060
Third	41,222,083	.0574	.0254	.0112	.0182	.0026	.0640	.0066
Fourth	48,204,354	.0623	.0264	.0111	.0213	.0035	.0664	.0041
Year	142,519,176	.0602	.0259	.0108	.0204	.0031	.0667	.0065

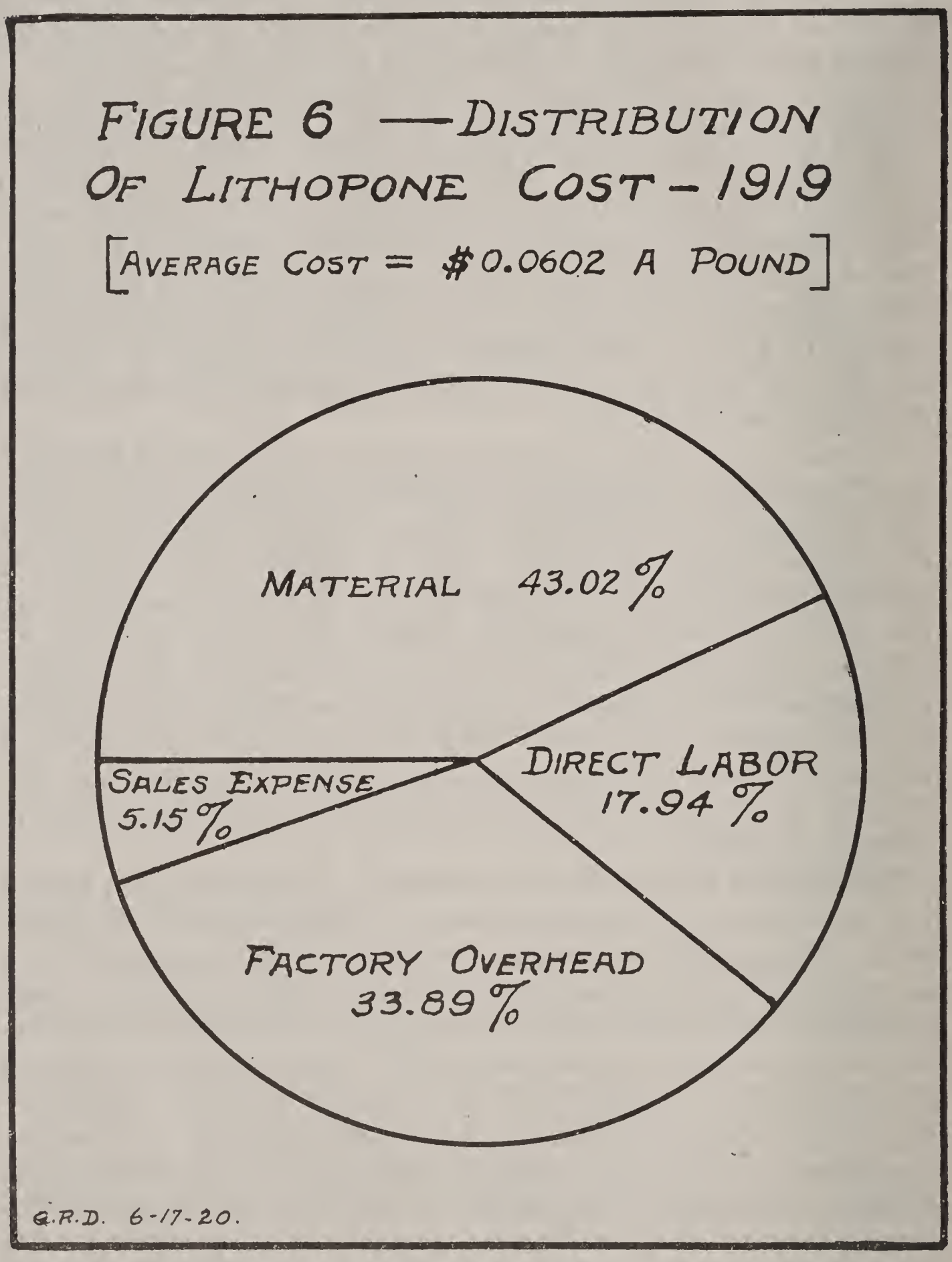
Table 40 shows the weighted average cost of lithopone for all plants by quarters during 1919. The total average cost for all companies reporting, as shown, is the sum of the items—material, direct labor, factory overhead, and selling expense. This table also shows in column 9 the average profit for the industry by comparing the average gross selling price with the total weighted average cost.

Column 2 shows the production of lithopone by the companies reporting costs during 1919, by quarters. These figures of production were used in obtaining the weighted average costs for each quarter and for the entire year 1919. The figures, however, do not necessarily represent total production of lithopone, because of the omission of certain companies who did not report costs for the whole year. These figures show inactivity in the lithopone industry during the first half of 1919. The production as shown during the first six months was only 53,000,000 pounds, as against 89,500,000 during the last six months of 1919.

Column 3 shows that the total weighted average cost of lithopone for all companies during 1919 was $0.0602 per pound. This average cost was made up of $0.0259 per pound, or 43 per cent for material; $0.0108 per pound, or 17.9 per cent for direct labor; $0.0204 per pound, or 33.9 per cent for overhead; and $0.0031 per pound, or 5.2 per cent for sales expense. The distribution of the total cost of lithopone according to items of expense for the year 1919 is shown diagrammatically in Figure 6. Column 3 also shows that the highest cost for lithopone was $0.0639 per pound during the first quarter of the year. The cost during the second and third quarters was uniform at $0.0573 per pound and increased in the fourth quarter to $0.0623 per pound.

The material cost, as shown in column 4, is the actual unit cost of raw materials used in the manufacture of lithopone, as shown by the books of the various companies. The items making up material cost, as recorded by the various manufacturers, differed greatly. Some companies reported the basic raw materials—barytes, coal for reduction of barytes, zinc, and sulphuric acid. Other companies reported the intermediate materials—barium sulphide and zinc sulphate—which are made from the basic raw materials given above. The relation between the basic raw materials and the intermediate materials, barium sulphide and zinc sulphate, is shown in the diagram of the manufacture of lithopone, Figure 4, page 55. In other words, by this latter method the companies carry separate cost accounts for the intermediate products, barium sulphide and zinc sulphate, and then charge these products at the actual cost of manufacture against their lithopone account as raw materials. Where this latter method has

been followed we have attempted to segregate the cost of zinc sulphate and barium sulphide into labor, raw material, and overhead. This estimated segregation has been done by determining the percentages of labor, raw material, and overhead by a study of the sepa-



rate cost sheets for zinc sulphate and barium sulphide and then applying these percentages in distributing the charges for the zinc sulphate and barium sulphide, as reported under lithopone cost, to raw material, labor, and overhead. The amounts due to labor and over-

head have been deducted from the lithopone material charge and added to labor and overhead reported under lithopone cost. This method of distribution may result in slight discrepancies between individual cost items, but in no case has the total material charge, as reported by any company, been changed unless an offsetting change has been made in some other department of cost, so that the total cost for any company has not been changed because of this arbitrary method of allocation. Column 4 shows that the average material cost for all companies during the year 1919 was $0.0259 per pound of lithopone, or 43 per cent of the total average cost. This column also shows that the material costs followed the general trend of the total cost during the year, although there was only a difference of 0.1 cent per pound between the material cost by quarters. The highest material charge was $0.0264 during the first and fourth quarters, while the material charge for the second and third quarters was uniform at $0.0254 per pound.

The direct labor cost, as shown by column 5, is derived from the figures reported by the companies plus any labor charge resulting from the arbitrary allocation due to differences in reporting raw materials, as discussed above under column 4. Column 5 shows that the average direct labor charge for all companies during 1919 was $0.0108 per pound, or 17.9 per cent of the total cost. The direct labor charge was fairly uniform during the year, and ranged from $0.0101 in the first quarter to $0.0112 in the third quarter.

The factory overhead cost shown in column 6 is made up of the five general charges—works expense, bags and barrels, fixed charges, laboratory expense, and administrative expense. These units have been derived from the report as submitted by the respective manufacturers, with the exception of those companies which reported interest on capital invested in inventory, building, machinery, and equipment, as a charge against lithopone costs. Where these items were given, they have been excluded in arriving at the total average cost of production. This has been necessary for purposes of comparison, because these charges were not reported by all companies, and in many cases where reported they were not actual book charges. There have also been a few minor changes in overhead expense, as reported by companies, which was necessary because of the arbitrary allocation of material charges, as previously explained under column 4 of this table. Column 6 shows that the average factory overhead for all companies during 1919 was $0.0204 per pound of lithopone, or 33.9 per cent of the total average cost. This charge ranged during the year from $0.0182 in the third quarter to $0.0239 during the first quarter.

Column 7 shows the total selling expense charged by the various manufacturers to their lithopone account. Selling expense as reported showed considerable variation in regard to both the method of determination and the relative amounts which were charged. Several of the firms manufacturing lithopone have large sales organizations which also handle other products. Some of these companies distribute the expense of the whole sales organization to the various products according to the value of the sales of the individual products. Those companies making only lithopone usually charged the actual cost of sales. Two other methods were found to be used in determining sales expense. One is to charge a certain percentage of the selling price as sales expense; one firm using this method combines sales and administrative expense. The other is to charge a fixed sum per unit of lithopone produced as sales expense. In all cases, however, the amounts as reported by individual companies have been included in the total average cost of lithopone. Column 7 shows that the average selling expense during 1919 was $0.0031 per pound of lithopone, or 5.2 per cent of the total cost. The selling cost ranged from $0.0025 in the second quarter to $0.0035 in the first and fourth quarters.

In determining the average price received by all companies, as shown in column 8, the gross price received by each company has been used. This unit has been multiplied by the total production of each company and the aggregate for all companies divided by the total production of all companies. By this method the weighted average gross sales price has been obtained. In the case of the few companies not reporting gross sales price, these companies have been omitted in arriving at the weighted average for each quarter and the year. Column 8 shows that the average gross sales price during 1919 was $0.0667 per pound of lithopone. In column 9 is shown the apparent average gross profit, obtained by subtracting the average total cost (column 3) from the average gross sales price (column 8). This estimated average profit during 1919 was $0.0065 per pound of lithopone. The profit shown during the year varied considerably—from $0.0041 in the fourth quarter to $0.0070 per pound in the first quarter.

VARIATION IN COSTS OF LITHOPONE, BY COMPANIES.

TABLE 41.—*Average cost per pound of lithopone during 1919, by companies.*

[Per pound.]

1	2	3	4	5	6	7	8
Plant No.	Total cost.	Material cost.	Direct labor cost.	Factory overhead.	Selling expense.	Average sales price.	Average profit or loss (−).
1	$0.0529	$0.0248	$0.0058	$0.0203	$0.0020	$0.0649	$0.0120
2	.0536	.0258	.0105	.0151	.0022	.0631	.0095
3	.0574	.0221	.0124	.0218	.0011	.0646	.0072
4	.0586	.0230	.0154	.0166	.0036	.0649	.0063
5	.0609	.0232	.0083	.0228	.0066	.0660	.0051
6	.0635	.0283	.0090	.0208	.0054	.0687	.0052
7	.0643	.0288	.0135	.0201	.0019	.0627	—.0016
8	.0653	.0307	.0211	.0121	.0014	.0696	.0043
9	.0697	.0251	.0111	.0324	.0011	.....	.....
10	.0744	.0303	.0095	.0276	.0070	.0714	.0030
11	.0751	.0329	.0085	.0271	.0063	.....	.....
Weighted average	.0602	.0259	.0108	.0204	.0031	.....	.....

Table 41 shows the cost of manufacturing lithopone by companies during the year 1919. This table also shows the average sales price received by each company and the average profit or loss of each firm with the exception of two companies for whom no sales price was reported.

Column 2 shows that the total cost of the 11 plants ranged from a low cost of $0.0529 per pound of lithopone to a high cost of $0.0751 per pound, a variation of about 40 per cent of the low cost. A study of this column shows that there were only four plants with a cost lower than the total weighted average of $0.0602 per pound. Based on production, however, about 60 per cent of the lithopone produced during 1919 was manufactured at a cost less than the average cost. The variation in costs between manufacturers is not in accordance with quantity production as might be expected. There are large producers represented in column 2 with high costs, and there are small producers with low costs.

Column 3 shows the material cost per pound of lithopone as reported by various manufacturers. This column shows a variation in material cost ranging from $0.0221 to $0.0329 per pound. The plant with highest material cost has the highest total cost, but the plant with the lowest material cost is not low in total cost. Six firms report a material cost below the average of $0.0259 per pound.

Column 4 shows the direct labor cost per pound of lithopone. This charge ranged from $0.0083 to $0.0211 per pound, a difference of 150 per cent of the low cost. Six plants show a direct labor cost below the average cost of $0.0108 per pound. The difference in labor

cost between the various manufacturers may be accounted for largely by design and equipment of plant. Although not all lithopone plants were visited by representatives of the Commission, those visited, which appeared to be well designed and utilized labor-saving devices wherever possible, uniformly show a low labor cost per pound of lithopone. There appears to be opportunity for plants with a high labor cost to lower their total cost of lithopone by a greater use of labor-saving devices and better design of plant.

Column 5 shows that the factory overhead per pound of lithopone ranged from a low cost of $0.0121 to a high cost of $0.0324. This is a difference of $0.0203 per pound, or about 165 per cent of the low cost. Five plants show a factory overhead charge lower than the average of $0.0204 per pound.

Column 6 shows the selling expense per pound of lithopone as reported by the different manufacturers. This charge ranged from $0.0011 to $0.0066 per pound of lithopone or a variation of 500 per cent of the low cost. This variation in selling expense is greater than for any other item of cost shown. Six plants show a selling expense lower than the average of $0.0031.

Column 7 shows the average net sales price received by each plant, with two exceptions. The average net price received for all sales during 1919 ranged from $0.0631 per pound to $0.$714 per pound, a variation of $0.0083 per pound. The sales price as shown in column 7 is not a quoted price on lithopone, but is the actual average net price received by each firm for sales during 1919; freight, discounts, and commissions have been deducted.

Column 8 shows the average profit or loss by companies represented by subtracting the total cost (column 2) from the average sales price obtained (column 7). As previously stated, interest on capital investment was not included in arriving at the total cost, and therefore this factor has had no influence on the average profit or loss shown in column 8. This column shows that one plant lost $0.0016 per pound of lithopone, while the other plants made a profit ranging from $0.0030 to $0.0120 per pound.

DETAILS OF MATERIAL COSTS.

TABLE 42.—*Details of material cost compared by percentages with total factory cost of lithopone during 1919, by companies.*

[Costs are per pound. Per cent is of total factory cost.]

1	2	3	4	5	6	7	8	9	10	11	12
Company No.	Total factory cost.	Total material.		Barytes.		Zinc.		Sulphuric acid.		All other materials.	
		Cost.	Per cent.	Cost.	Per cent.	Cost.	Per cent.	Cost.	Per cent.	Cost.	Per cent.
1	$0.0509	$0.0248	48.72	$0.0086	16.89	$0.0127	24.96	$0.0025	4.91	$0.0010	1.96
2	.0514	.0258	50.20	.0091	17.70	.0112	21.79	.0027	5.26	.0028	5.45
3	.0563	.0221	39.26	.0067	11.90	.0100	17.76	.0030	5.33	.0024	4.27
4	.0550	.0230	41.82	.0078	14.18	.0122	22.18	.0023	4.18	.0007	1.28
5	.0543	.0232	42.72	.0053	9.76	.0122	22.47	.0028	5.15	.0029	5.34
6	.0581	.0283	48.71	.0085	14.63	.0128	22.03	.0027	4.65	.0043	7.40
7	.0624	.0288	46.15	.0068	10.89	.0141	22.60	.0040	6.41	.0039	6.25
8	.0639	.0307	48.04	.0083	12.99	.0149	23.32	.0034	5.32	.0041	6.41
9	.0686	.0251	36.59	.0072	10.49	.0139	20.26	.0018	2.62	.0022	3.22
10	.0674	.0303	44.96	.0075	11.13	.0153	22.70	.0041	6.09	.0034	5.04
11	.0688	.0329	47.82	.0096	13.95	.0153	22.24	.0034	4.94	.0046	6.69
WEIGHTED AVERAGE OF ALL COMPANIES.											
First quarter, 1919	.0604	.0264	43.71	.0082	13.57	.0125	20.70	.0032	5.30	.0025	4.14
Second quarter, 1919	.0548	.0254	46.35	.0077	14.05	.0122	22.26	.0026	4.75	.0029	5.29
Third quarter, 1919	.0548	.0254	46.35	.0081	14.78	.0124	22.63	.0026	4.75	.0023	4.19
Fourth quarter, 1919	.0588	.0264	44.90	.0076	12.93	.0127	21.60	.0030	5.10	.0031	5.27
Year	.0571	.0259	45.37	.0079	13.84	.0124	21.72	.0029	5.08	.0027	4.73

Table 42 shows by companies the detail of material cost compared with total factory cost. This table also shows the weighted average material charge for all companies during each quarter and for the entire year of 1919. The total factory cost as shown in column 2 does not include sales expense and is the sum of material, direct labor, and factory overhead charges. The average factory cost for all companies during the entire year was $0.0571 per pound of lithopone produced. This is a weighted average of individual factory costs ranging from $0.0509 to $0.0688 per pound.

Column 3 shows that the total average material cost for the entire year was $0.0259 per pound, or 45.37 per cent of the total factory cost as shown by column 4. The cost of barytes, column 5, for all companies during 1919 averaged $0.0079 per pound of lithopone, or 13.84 per cent of the total factory cost, column 6. The percentage of the factory cost of lithopone due to crude barytes is important in considering a duty on crude barytes and its effects on the cost of lithopone. The average cost of the crude barytes as reported by 8 of the 11 plants was $13.60 per short ton. With this information the effect of an increase or decrease in the cost of crude barytes on the cost of lithopone can be calculated. For example, a 10 per cent increase or decrease in the cost of barytes given above ($13.60) will

cause an increase or decrease of 1.384 per cent of the total factory cost of lithopone.

An average of 8 of the 11 plants for which costs were reported shows that 1.2 pounds of barytes were required for the production of 1 pound of lithopone during 1919.

Column 7 shows that the average cost of zinc materials for all companies was $0.0124 per pound of lithopone, or 21.72 per cent of the total factory cost as shown in column 8. Zinc is seen to be the most expensive material entering into the cost of lithopone. Column 9 shows that the average cost of sulphuric acid per pound of lithopone for the year was $0.0029, or 5.08 per cent of the total factory cost as shown in column 10. Column 11 shows all other materials entering into the manufacture of lithopone. Under this heading is included coal used in reduction of barytes and various minor chemicals used principally in the purification of zinc liquor before it is used to make lithopone. The average cost of all other materials for 1919 was $0.0027 per pound of lithopone, or 4.73 per cent of the factory cost as shown in column 12.

It should be pointed out that the variation by companies of a given material cost per pound of lithopone and the percentage of factory cost do not necessarily follow each other. One firm may show a low unit cost for a given material, but the percentage of factory cost due to that material may be higher than the percentage shown by another firm with a higher unit cost.

DETAILS OF FACTORY OVERHEAD CHARGES.

TABLE 43.—*Details of factory overhead compared by percentages with total factory cost of lithopone during 1919, by companies.*

[Costs are per pound. Per cent is of total factory cost.]

1	2	3	4	5	6	7	8	9
Plant No.	Total factory cost.	Total factory overhead.		Details of factory overhead.				
		Cost.	Per cent.	Works expense.	Bags and barrels.	Fixed charges.	Laboratory.	Administration.
1	$0.0509	$0.0203	39.89	$0.0147	(1)	$0.0015	(1)	$0.0041
2	.0514	.0151	29.38	.0062	$0.0016	.0031	$0.0001	.0041
3	.0563	.0218	38.72	.0147	.0019	.0029	.0002	.0021
4	.0550	.0166	30.18	.0099	.0013	.0034	.0003	.0017
5	.0543	.0228	41.99	.0155	.0023	.0039	.....	.0011
6	.0581	.0208	35.80	.0163	.0021	.0004	.0006	.0014
7	.0624	.0201	32.21	.0141	.0018	.0034	.....	.0008
8	.0639	.0121	18.93	.0097	.0024	(1)	(1)	(1)
9	.0686	.0324	47.23	.0302	.0016	.0005	.0001	.....
10	.0674	.0276	40.95	.0214	.0025	.0009	.0007	.0021
11	.0688	.0274	39.83	.0221	.0026	.0009	.0006	.0012
WEIGHTED AVERAGE OF ALL COMPANIES.								
First quarter, 1919	.0604	.0239	39.57	.0168	.0016	.0025	.0002	.0028
Second quarter, 1919	.0548	.0191	34.85	.0126	.0012	.0025	.0002	.0026
Third quarter, 1919	.0548	.0182	33.22	.0124	.0016	.0018	.0002	.0022
Fourth quarter, 1919	.0588	.0213	36.22	.0153	.0020	.0018	.0003	.0019
Year	.0571	.0204	35.73	.0142	.0016	.0021	.0002	.0023

[1] Not shown separately but is included in works expense.

Table 43 shows the details of factory overhead compared with total factory cost of lithopone during 1919 by individual plants. This table also shows average factory overhead charges for all companies during each quarter and for the entire year of 1919. The total factory cost and factory overhead per pound of lithopone by companies have been discussed in the preceding pages.

Column 4 shows that the average factory overhead of all plants during 1919 was 35.73 per cent of the total factory cost. It should be pointed out at this point that since some of the plants do not show factory overhead in the same detail as shown in this table by columns 5 to 9, the total factory overhead is the only fair basis of comparison between plants. Although in many cases the units under detail of factory overhead can not be used for direct comparison, the table shows the variation in the detail to which the various plants distribute their overhead expense.

Column 5 showing works expense includes such items as indirect labor, fuel, power, light, and general factory expense. The average works expense for all companies was $0.0142 per pound of lithopone. The costs given under bags and barrels, column 6, is for packages of any kind. Only one plant did not report a separate charge for this item, but included it in works expense. This item is small and fairly uniform for all companies. The average cost for packages during the year was $0.0016 per pound of lithopone.

Fixed charges, column 7, include items of expense such as insurance, depreciation, and State and local taxes. In all cases but one the charge reported is an actual expense and not an estimated one. One firm included fixed charges in works expense. The average of all plants reporting such charge for 1919 was $0.0021 per pound of lithopone. Column 8 shows the expense due to maintenance of a chemical laboratory. This charge was shown separately by seven plants. In all cases the charge for laboratory was small.

Administration charges as shown in column 9 represents salaries paid to executives and general office expense. The charges vary greatly with the size of the organization, but as the charge is relatively small it has little effect on the total cost of lithopone. The methods used by various companies in arriving at administrative expenses are practically the same as the methods used in determining sales expense, namely, actual expense, percentage of sales price, or a fixed sum per unit of product.

DETAILS OF SPECIAL CHARGES.

TABLE 44.—*Details of special charges per pound of lithopone, by companies, during 1919.*

[Per pound.]

1	2	3	4	5
Company No.	Total of special charges.[1]	Depreciation.	Interest on borrowed money.	Imputed interest.[2]
1	$0.0015	$0.0015	.....	.....
2	.0016	.0016	.....	.....
3	.0027	.0027	.....	$0.0021
4	.0026	.0020	$0.0006	.....
5	.0040	.0033	.0007	.0021
6	.0003	.0003	.....	.....
7	.0032	.0022	.0010	.....
8	.....	.....	.....	.....
9	.0005	.0005	.....	.....
10	.0009	.0009	.....	.....
11	.0009	.0009	.....	.....
Weighted average	.0018	.0017	.....	.....

[1] Total special charges included in total factory overhead.
[2] Imputed interest not included in costs of lithopone production.

Table 44 shows the detail of special charges per pound of lithopone during 1919 by companies. The total special charges in column 2 were included in total factory overhead. The total average special charges were $0.0018 per pound of lithopone and ranged by companies from no charge to a charge of $0.0040 per pound.

Imputed interest or interest on capital invested in inventories, buildings, and equipment, as shown in column 5, was not included in the total cost of lithopone. It is given here to show that it was considered a cost by two plants.

Depreciation shown in column 3 is on buildings and equipment. Generally the depreciation is a certain percentage of the investment in buildings and equipment and ranges from 1 to 15 per cent. In one case the depreciation is figured as a percentage of the appraised value. In another instance depreciation was not included as a current cost, but was charged to profit and loss at the end of each fiscal year. In some cases a uniform rate of depreciation was applied to both building and equipment, while in other cases a different rate was applied to buildings than to equipment. As shown in column 3, depreciation is the chief special charge and averaged $0.0017 per pound of lithopone for 1919. Column 4 shows that interest on borrowed money was charged against lithopone costs by three plants. This has been included in the total cost.

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